THE American JOURNAL OF Surgery

NOVEMBER 1957

THURSTON SCOTT WELTON, M.D., EDITOR

SIXTY-SIXTH YEAR OF PUBLICATION

NOVEMBER 1957

THE American JOURNAL OF Surgery

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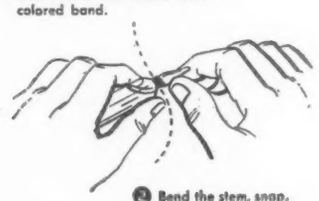

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FRANK COLE

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Twenty-two cases of partial anomalous venous drainage are discussed. The pathologic physiology, classification of the various types, the surgical management, and the post-operative results are offered.

Arterial Homografts. Experience with End-to-side Vascular Anastomosis . . . 695

J. HAROLD CONN AND KONSTANTIN SPARKUHL

An analysis is presented of the short term results following end-to-side anastomosis of five arterial homografts. The immediate results indicate a high percentage of patency with excellent blood flow distally. The technic of operations is outlined. Performance of end-to-side anastomosis preserves the collateral circulation, a safety factor if thrombosis of the graft occurs.

The Effect upon Free Hydrochloric Acid Production of Heidenhain Pouches with Variation in Size and Position of a Gastrojejunostomy Stoma. 705

THOMAS W. JONES, JOHN K. STEVENSON, JOHN E. JESSEPH, LLOYD M. NYHUS AND HENRY N. HARKINS

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The American Journal of Surgery is published monthly by The American Journal of Surgery, Inc., 11 East 36th Street, New York 16, N. Y. Yearly Subscription, $15.00 U. S. A.; $16.00 Canada; $17.00 Foreign including Pan-American Countries. Single Numbers $2.00; Special and Symposium Numbers $4.00. Re-entered as second class matter February 7, 1951, at the Post Office, New York, N. Y., and on February 7, 1951, at York, Pa., under the Act of March 3, 1879. November, 1957—New Series, Volume 94, No. 5. *Copyright ©, 1957, by The American Journal of Surgery, Inc.*

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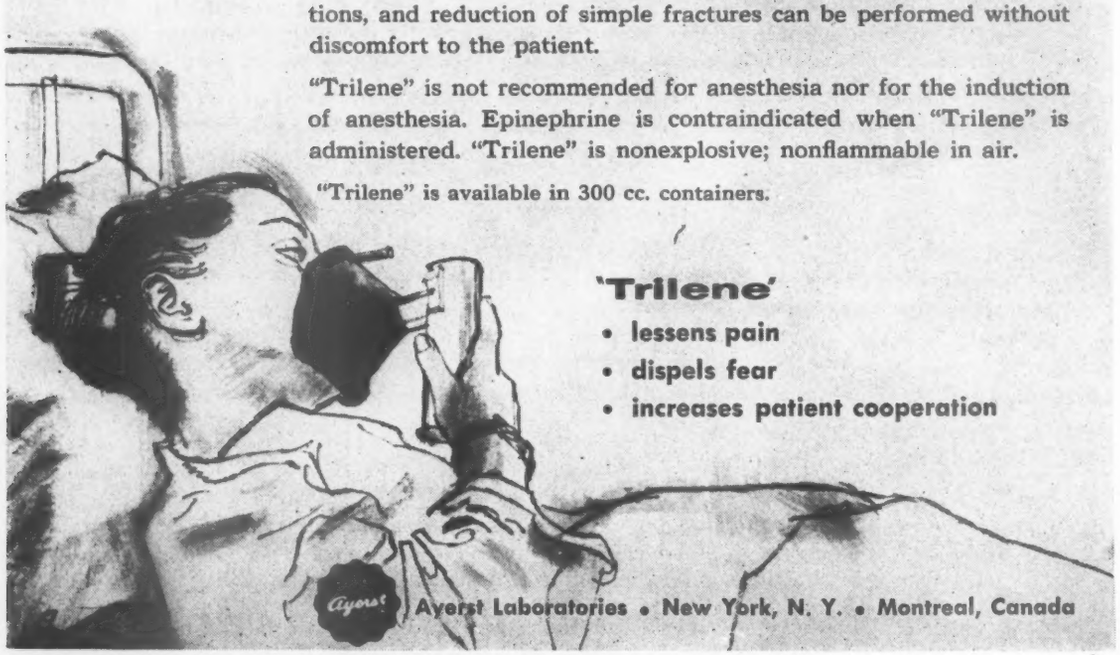

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Under the conditions in this experimental study it was found that there was only a moderate increase in Heidenhain pouch secretion following a low antral gastrojejunostomy if the stoma was constructed 2 cm. in diameter. If the gastrojejunostomy stoma was constructed 4 cm. in diameter there was a marked increase. The average increase in secretion of free hydrochloric acid from the Heidenhain pouch when stimulated by a 2 cm. diameter gastrojejunostomy stoma was 43.3 per cent; for a 4 cm. stoma the similar average was 144.9 per cent.

Pseudomembranous Enterocolitis 710

HARRY W. HALE, JR. AND JAMES H. COSGRIFF, JR.

A series of fifteen cases of pseudomembranous enterocolitis is presented. Twelve of these cases were recognized clinically, with five survivals. The course and management are discussed and suggestions made for prophylaxis against the disease.

Massive Gastrointestinal Hemorrhage of Undetermined Origin 718

B. N. DOOLEY, WM. B. GORDON AND L. L. D. TUTTLE

The authors briefly allude to massive gastrointestinal hemorrhage in general, commenting on approaches to the issue currently. Three cases are reported showing vague causes. In one case the treatment is defined.

Postgastrectomy Hemorrhage 723

ANGELO M. MAY

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A Statistical Analysis of the Fluid and Electrolyte Requirements of Surgical Patients 727

CARL O. RICE, J. H. STRICKLER AND VERNON WECKWERTH

After complete balance study on 102 patients for nitrogen, fluid and electrolytes, a solution is recommended for each of the three phases in the surgical management of patients. Minimum average values are taken as a reasonably safer base line from which additional requirements may be added. It is suggested that a single solution may be used as a base line, taking minimum quantity from either of the phases, preoperative, surgery and postoperative. Such a solution contains 6 gm. nitrogen, 17 mEq. potassium, 22 mEq. sodium and 23 mEq. chloride per liter. The minimum average fluid requirement is 2.5 L. per day.

The Case for Motion and Time Study in Surgery 730

J. V. MCKENNA

The author outlines what motion study is capable of, the philosophy and technics of motion and time study, and refutation of objections to the use of motion and time study in surgery.

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Titanium for Femoral Head Prosthesis 735

GOTTLIEB S. LEVENTHAL

A review of this small group of patients seems to indicate that titanium is a metal worthy of consideration as a prosthesis in selected cases in which reconstruction arthroplasty is considered.

Prosthetic Replacement of the Mid-shaft of the Radius of the Dog 741

WILLIAM I. GAY

A study of the effect of replacing one-half of the shaft of a partial non-weight bearing bone in the dog. The radius was selected because it is splinted by the ulna which participated in supporting the weight of the front quarter of the body. Results of the use of the prosthesis, constructed of titanium metal, are discussed.

Fractures of the Shaft of the Tibia in Adults Treated with Multiple Wire Fixation 747

CATALINO T. JOCSON

This study is based on seventy-eight fractured tibias in adults, of which thirty-two were open and forty-six were closed fractures. Thirty-three were treated with plaster cast immobilization, thirty-four had multiple wire and plaster fixation, eight had internal skeletal fixation, and three had skeletal traction. The technic of applying multiple wire and plaster fixation is described, with illustrative case reports and results.

Investigation of Promethazine in a General Surgical Practice. 757

JAMES R. ARNEILL

Promethazine was administered parenterally or orally to a series of forty-seven patients operated upon under general anesthesia, in an effort (which was successful) to reduce the dosage of the standard narcotic and hypnotic agents required for preanesthetic and postsurgical sedation. Method of administration. Results have led to the routine administration of this drug to surgical patients at the Arneill Medical Center.

The Embryologic Basis for the Clinical Manifestations of Midgut Volvulus. . . 762

JOHN L. BEATTIE

The normal embryologic process of rotation of the gut must be understood for the proper diagnosis and management of rotational anomalies. Most midgut volvuli occur in a clockwise direction. Reducing the volvulus and not releasing a peritoneal band obstructing the duodenum may be a fatal error. Postoperative complications are discussed, with a report of two illustrative cases.

Management of Injury to the Head in Patients with Multiple Injuries 768

EVERETT G. GRANTHAM

Approximately 30 per cent of patients hospitalized with injuries to the head will require intracranial surgery. However, among this group only a small number with acute intracranial bleeding must be operated upon in a very short time. In other patients multiple body injuries often require more immediate attention than the injury to the head.

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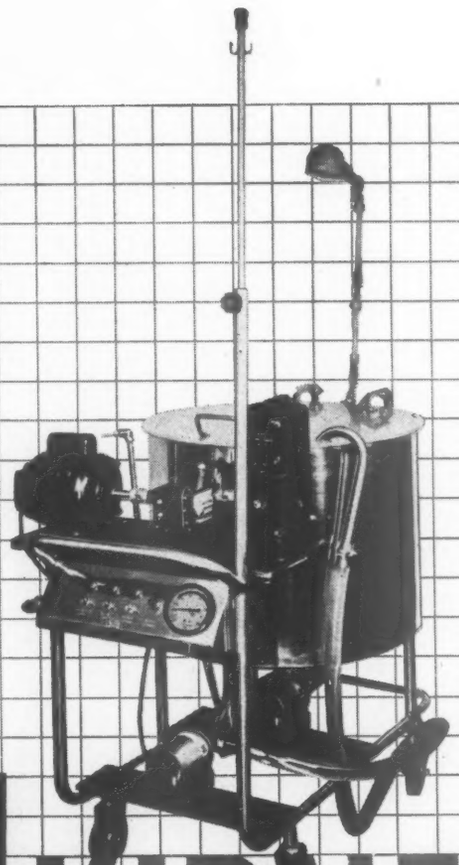

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Acute Perforation of the Gallbladder 772

L. MORSE, B. KRYNSKI AND CAPT. A. R. WRIGHT

Twenty-five consecutive cases of perforation of the acutely inflamed gallbladder during the twelve-year period from January, 1944 to March, 1956 are presented. During this period 542 patients were admitted with a diagnosis of acute cholecystitis, for an incidence of perforation of 4.6 per cent and a mortality rate after perforation of 44 per cent. When to operate in various types of cases is discussed.

Jejunogastric Intussusception Following Subtotal Gastrectomy. An Illustrative Case Report 776

JOHN VAN PROHASKA, MICHAEL C. GOVOSTIS, HERMAN P. HARMS AND SHIRL O. EVANS

The fifteenth case of jejunogastric intussusception following subtotal gastrectomy is presented. An "open" method of reduction of an irreducible intussusception is described. The therapy consists of immediate surgical intervention.

The Use of Trypsin (Intramuscular) in the Treatment of Edema Due to Intestinal Anastomosis 781

A. LEE LICHTMAN

Crystalline trypsin in sesame oil given intramuscularly to patients in whom intestinal anastomoses were performed produces earlier resumption of effective intestinal peristalsis.

Emphysema of One Lung Associated with Atresia of the Contralateral Pulmonary Artery 784

JOHN R. DERRICK AND JOHN M. HOWARD

Unilateral emphysema in an infant is suggestive of atresia of the contralateral pulmonary artery, after other causes of unilateral emphysema have been excluded. The anomaly appears to be associated with the tetralogy of Fallot more often than any other isolated cardiac defect. Most of the cases may be diagnosed by a routine x-ray of the chest, but in questionable cases angiocardiography may be necessary. An illustrative case is reported.

Torsion of the Spermatic Cord in Adult Scrotal Testes. A Review of Eighteen Cases Managed Surgically 787

LT. COL. EDWARD GARTMAN

Ten cases of acute strangulating and eight of recurring, spontaneously reducing torsion of the spermatic cord in scrotal testes are reviewed. In ten cases of acute strangulation only four testicles were saved, but in none of the eight cases of recurring torsion was a testicle lost. Surgical fixation of both testes has proved well merited after a diagnosis of recurring, spontaneously reducing torsion of the spermatic cord has been made.

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MODERN OPERATIVE TECHNICS

Immediate Replacement of Tissue Losses from Hand or Wrist by Means of Bipedicled Cross Arm Flaps 790

ARTHUR W. VON DEILEN AND JAMES B. COX

The authors describe the surgical technic of bipedicled cross arm flaps in the immediate replacement of tissue losses from hand or wrist. Two illustrative cases are reported.

Relief of Ascites with or without Anasarca, a New Procedure. Preliminary Report 794

JOSEPH L. MAGRATH

Description of the operative technic for using an acrylic plastic tube designed for the palliative treatment of ascites and ascites with anasarca. An illustrative case is reported.

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Gas Gangrene of the Abdominal Wall Following Appendectomy 798

WARREN P. KNUTH AND BENEDICT R. WALSKE

A case is presented of gas gangrene of the abdominal wall following surgery. The authors outline a therapeutic program which includes the use of gas gangrene antitoxin, antibiotics and surgical treatment with wide excision and débridement of involved tissue.

Splenectomy in Sarcoidosis. 802

ARNOLD S. JACKSON

The author claims there is no reason for performing splenectomy in sarcoidosis except where the spleen reaches such size as to encroach upon and embarrass the other organs. The preoperative beneficial effect of cortisone in reducing the size of the spleen, as previously reported by others, is reconfirmed.

Adrenalectomy in Advanced Cancer of the Breast 806

THOMAS C. CASE

A case of far advanced carcinoma of the breast is presented in which adrenalectomy and oophorectomy produced dramatic results. A plea not to underestimate palliative surgery.

Primary Hodgkin's Disease of the Stomach 808

HOUTZ G. STEENBURG AND DONALD M. CLOUGH

A brief summary of the literature on gastric Hodgkin's disease together with the forty-first case report of primary gastric lymphogranulomatosis, which was treated by subtotal gastric resection followed with radiation.

Congenital Pulmonary Cyst 812

M. L. CANTLIN, JOSEPH J. MAIORIELLO AND WARD D. O'SULLIVAN

The successful removal of a large congenital pulmonary cyst in a six month old infant is reported. Early extirpative surgery before the appearance of complications is recommended.

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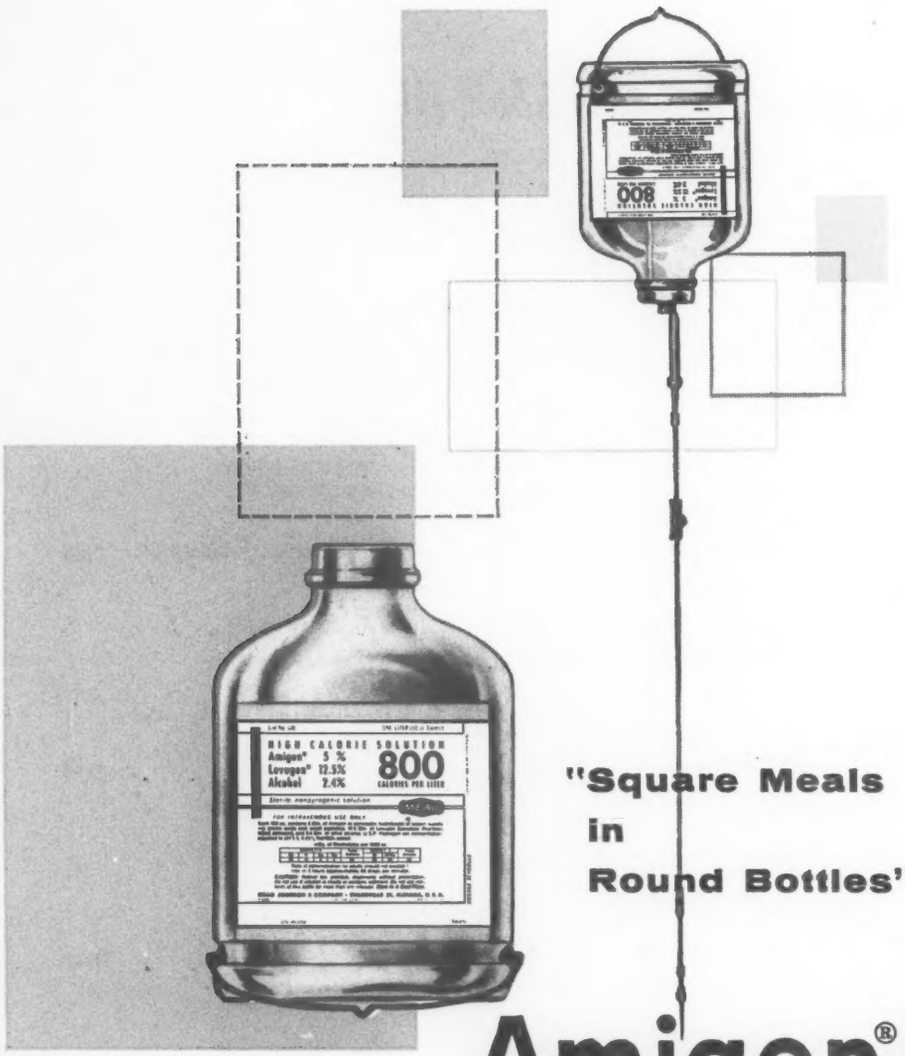

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Retroperitoneal Rupture of the Duodenum Due to Blunt Trauma 816

ROBERT W. HANSEN AND FRANCIS R. WILLIAMS

The authors present a case of retroperitoneal transection of the duodenum, with acute hemorrhagic pancreatitis, in which the patient recovered, probably due to the successful application of two new methods of care.

Intussusception of the Appendix Due to Carcinoma 820

JEROME J. WEINER AND ANGELO M. SALA

The case presented is of interest because the appendiceal intussusception was produced by a papillary adenocarcinoma of the appendix in a fifteen year old boy.

One-Stage Reconstruction of the Abdominal Wall 825

JOHN C. GAISFORD, LUCIAN J. FRONDUTI AND JAMES B. MEDLOCK

A report of a case of recurrent carcinoma of the transverse colon with direct invasion of the anterior abdominal wall, including the skin, with a description of the technic of reconstruction of a large through and through defect of the abdominal wall, performed in one stage.

Retrocecal Hernia 829

HAROLD S. TIDLER AND JOSEPH M. MILLER

A discussion of the pathogenesis, incidence and treatment of retrocecal hernias. The successful management of a patient with a retrocecal hernia is reported.

Swelling of the Round Ligament Resembling an Acutely Incarcerated Inguinal Hernia 832

WARREN A. CLOHISY, JR.

In this unusual case swelling of the round ligament prompted a preoperative diagnosis of an acutely incarcerated inguinal hernia. No report of a similar case has been found in the literature.

In Memoriam, Rudolph Matas, M.D., LL.D., F.A.C.S. 835

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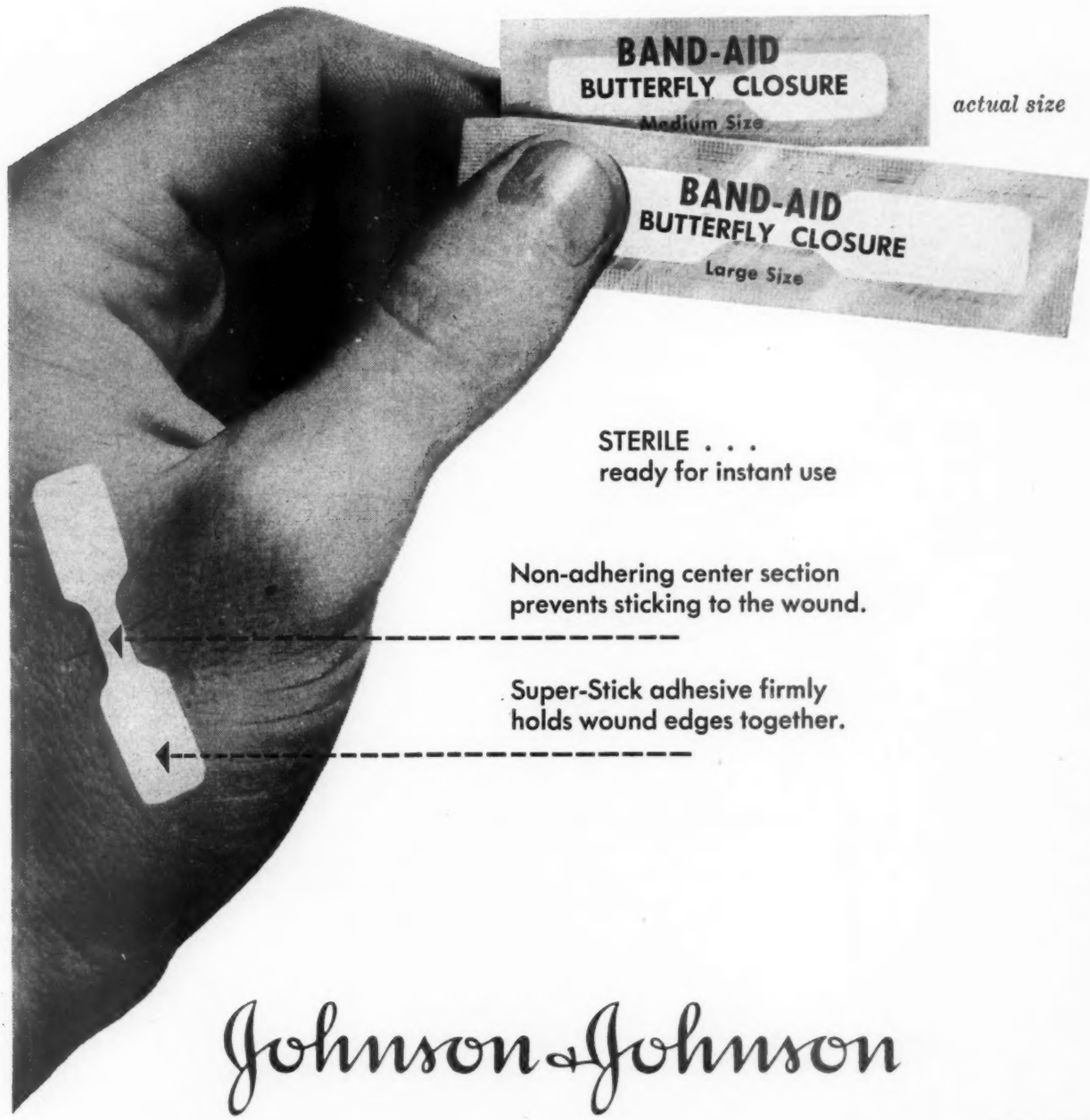

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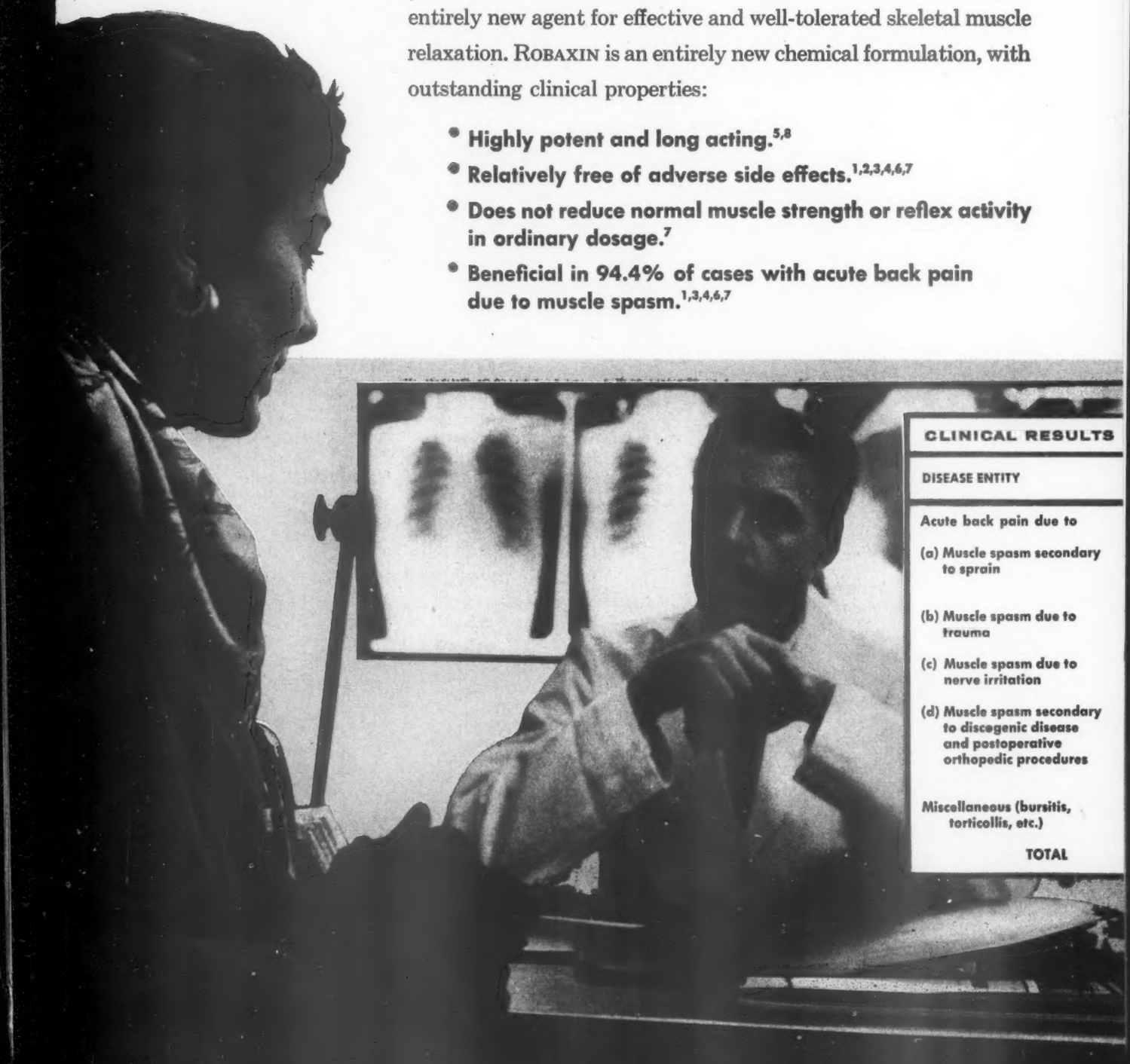

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NO. OF CASES	DURATION OF TREATMENT	DOSE PER DAY (divided)	RESPONSE marked	mod.	slight	neg.	SIDE EFFECTS
18	2-42 days	3-6 Gm.	17	1	0	0	None, 16 Dizziness, 1 Slight nausea, 1
13	1-42 days	2-6 Gm.	8	1	3	1	None, 12 Nervousness, 1
5	4-240 days	2.25-6 Gm.	4	1	0	0	None, 5
30	2-28 days	1.5-9 Gm.	24	3	0	3	None, 25 Dizziness, 1 Lightheadedness, 2 Nausea, 2 *
6	3-60 days	4-8 Gm.	6	0	0	0	None, 6
72			59	6	3	4	*Relieved on reduction of dose

References: 1. Carpenter, E. B.: Publication pending. 2. Carter, C. H.: Personal communication. 3. Forsyth, H. F.: Publication pending. 4. Freund, J.: Personal communication. 5. Morgan, A. M., Truitt, E. B., Jr., and Little, J. M.: American Pharm. Assn. 46:374, 1957. 6. Nachman, H. M.: Personal communication. 7. O'Doherty, D.: Publication pending. 8. Truitt, E. B., Jr., and Little, J. M.: J. Pharm. & Exper. Therap. 119:161, 1957.

Indications – Acute back pain associated with: (a) muscle spasm secondary to sprain; (b) muscle spasm due to trauma; (c) muscle spasm due to nerve irritation; (d) muscle spasm secondary to discogenic disease and postoperative orthopedic procedures; and miscellaneous conditions, such as bursitis, fibrositis, torticollis, etc.

Dosage – Adults: Two tablets 4 times daily to 3 tablets every 4 hours. Total daily dosage: 4 to 9 Gm. in divided doses.

Precautions – There are no specific contraindications to Robaxin and untoward reactions are not to be anticipated. Minor side effects such as lightheadedness, dizziness, nausea may occur rarely in patients with unusual sensitivity to drugs, but disappear on reduction of dosage. When therapy is prolonged routine white blood cell counts should be made since some decrease was noted in 3 patients out of a group of 72 who had received the drug for periods of 30 days or longer.

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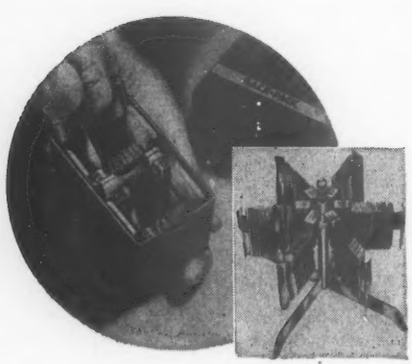

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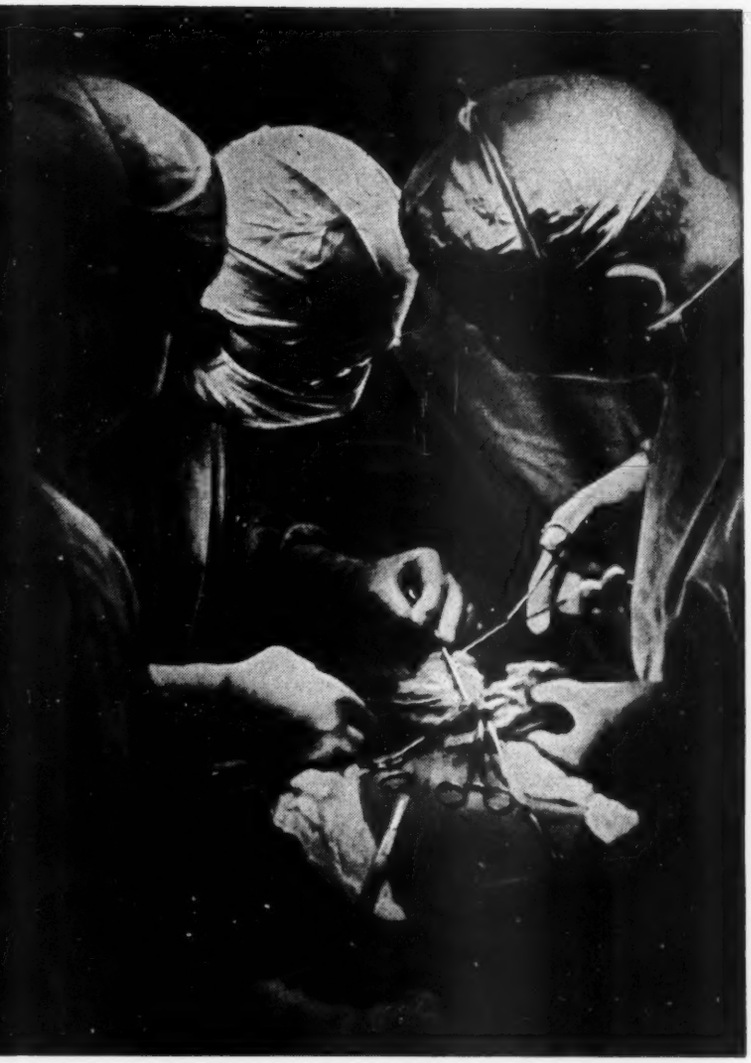

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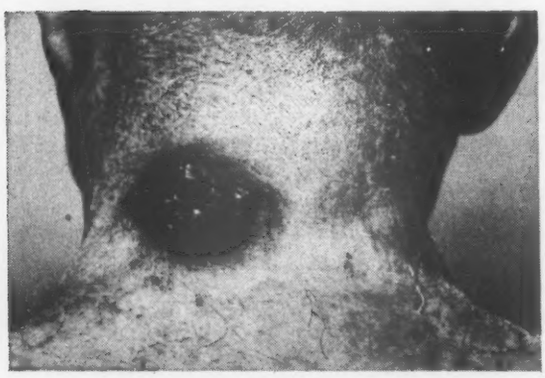

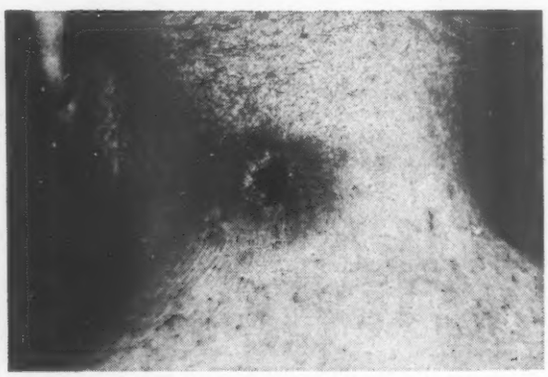

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References: (1) Miller, E. W.: New York J. Med. *56*:1446, 1956. (2) Gaines, A. L., and Barnard, R. D.: Angiology *8*:13, 1957. (3) Morrison, J. E., and Casali, J. L.: Am. J. Surg. 93:446, 1957. (4) Wood, O. H.: Maryland M. J., in press.

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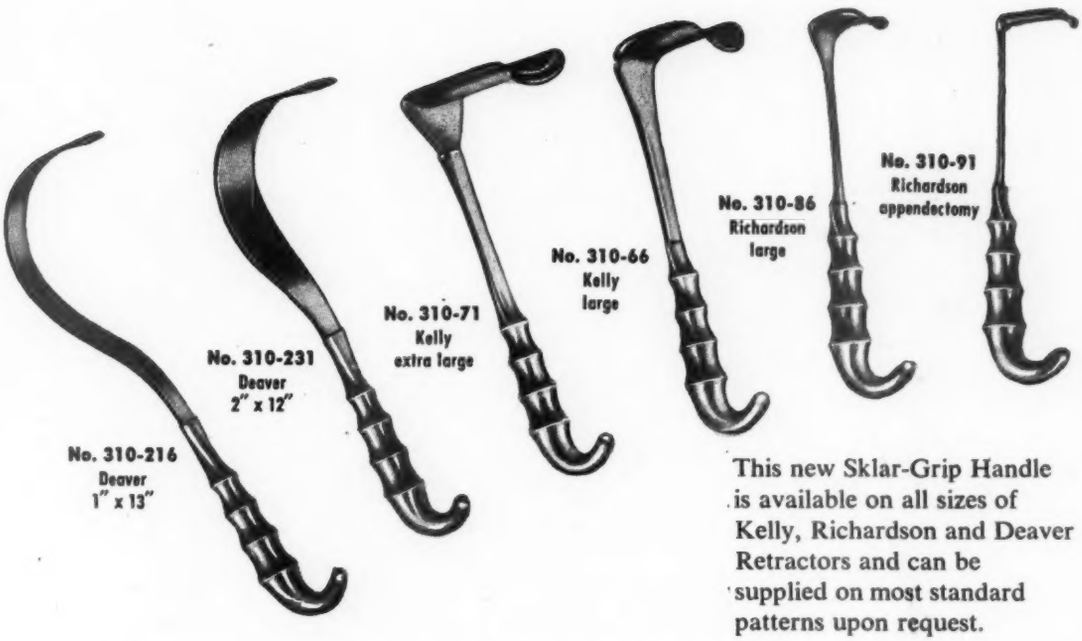

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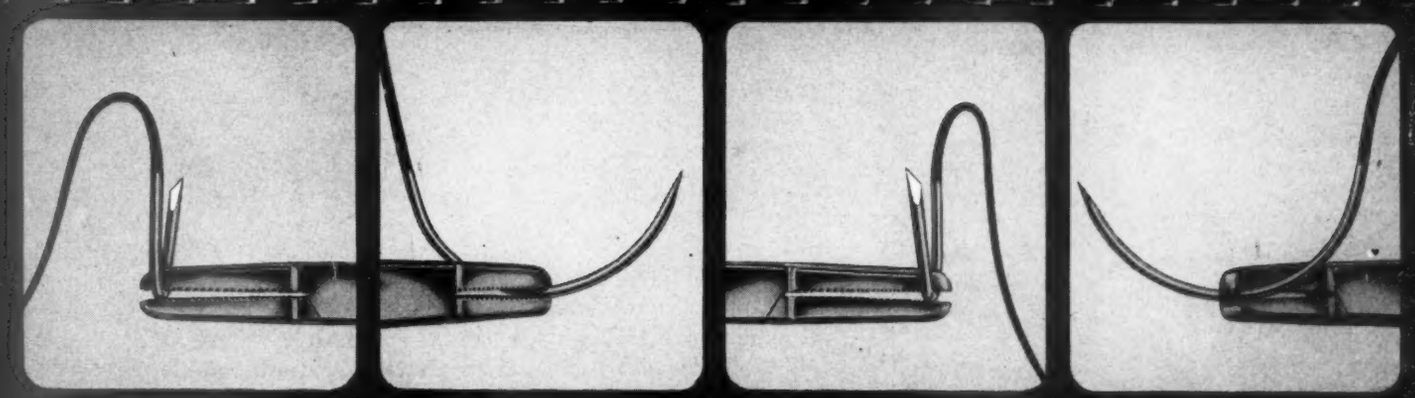

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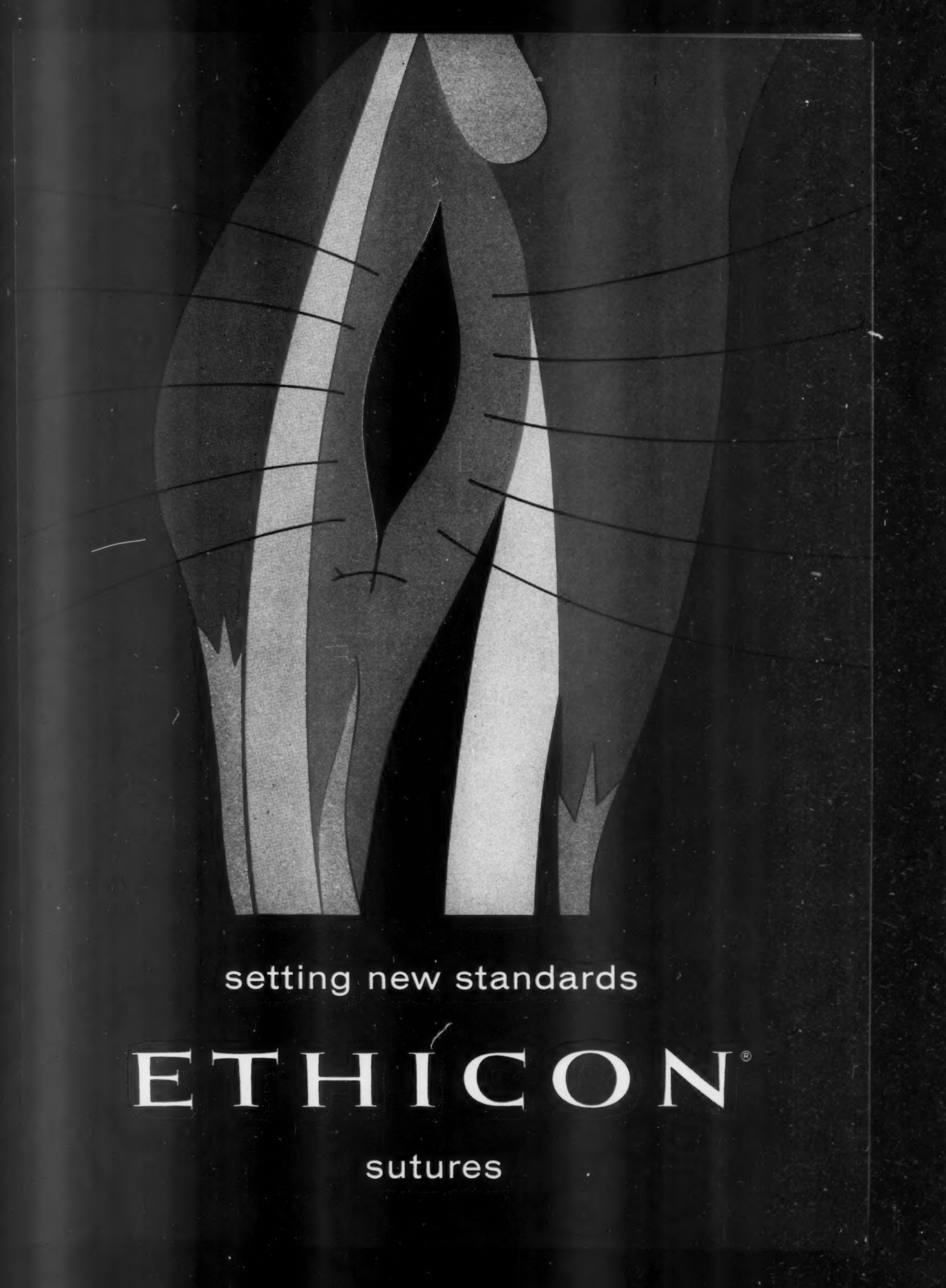
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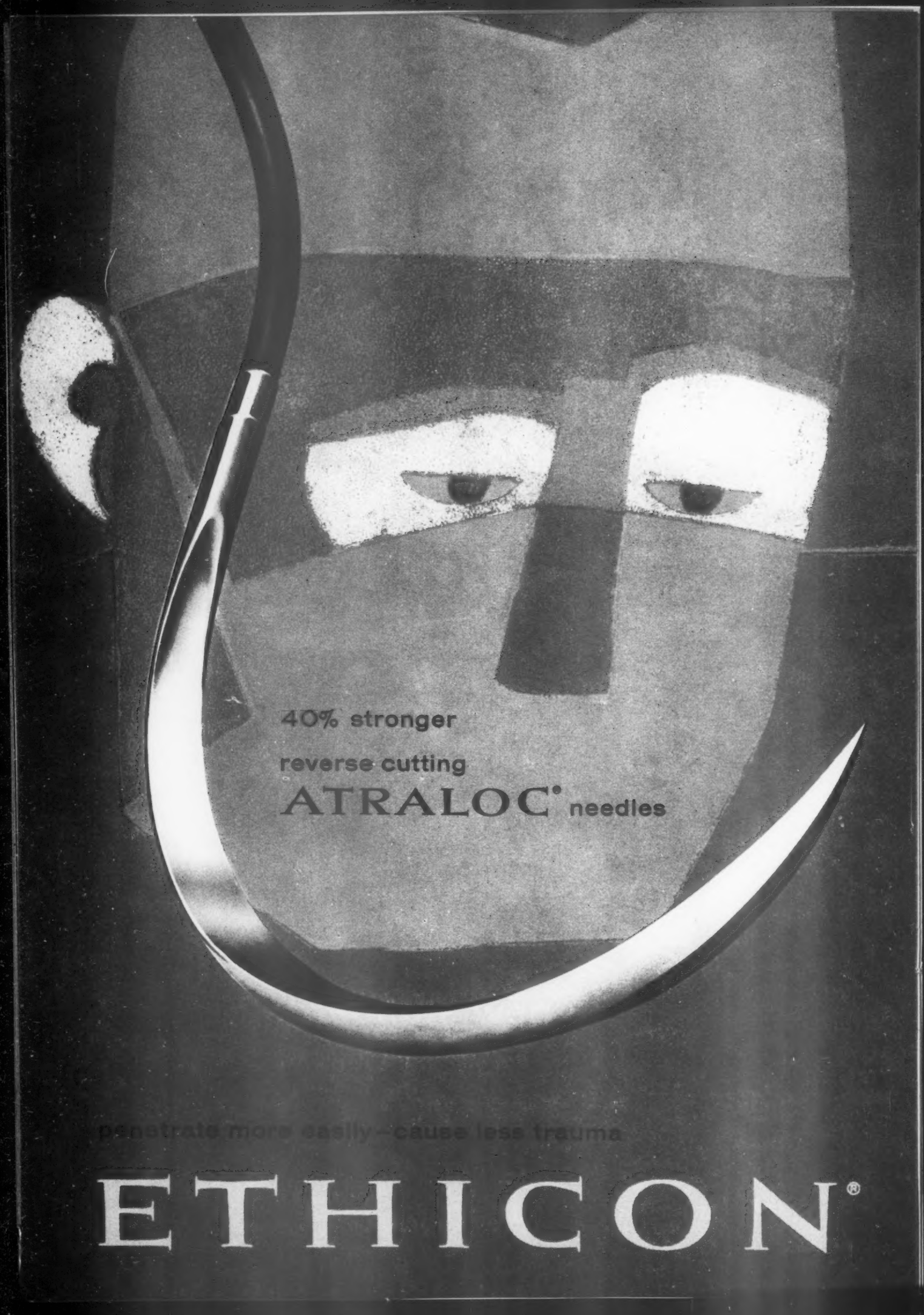
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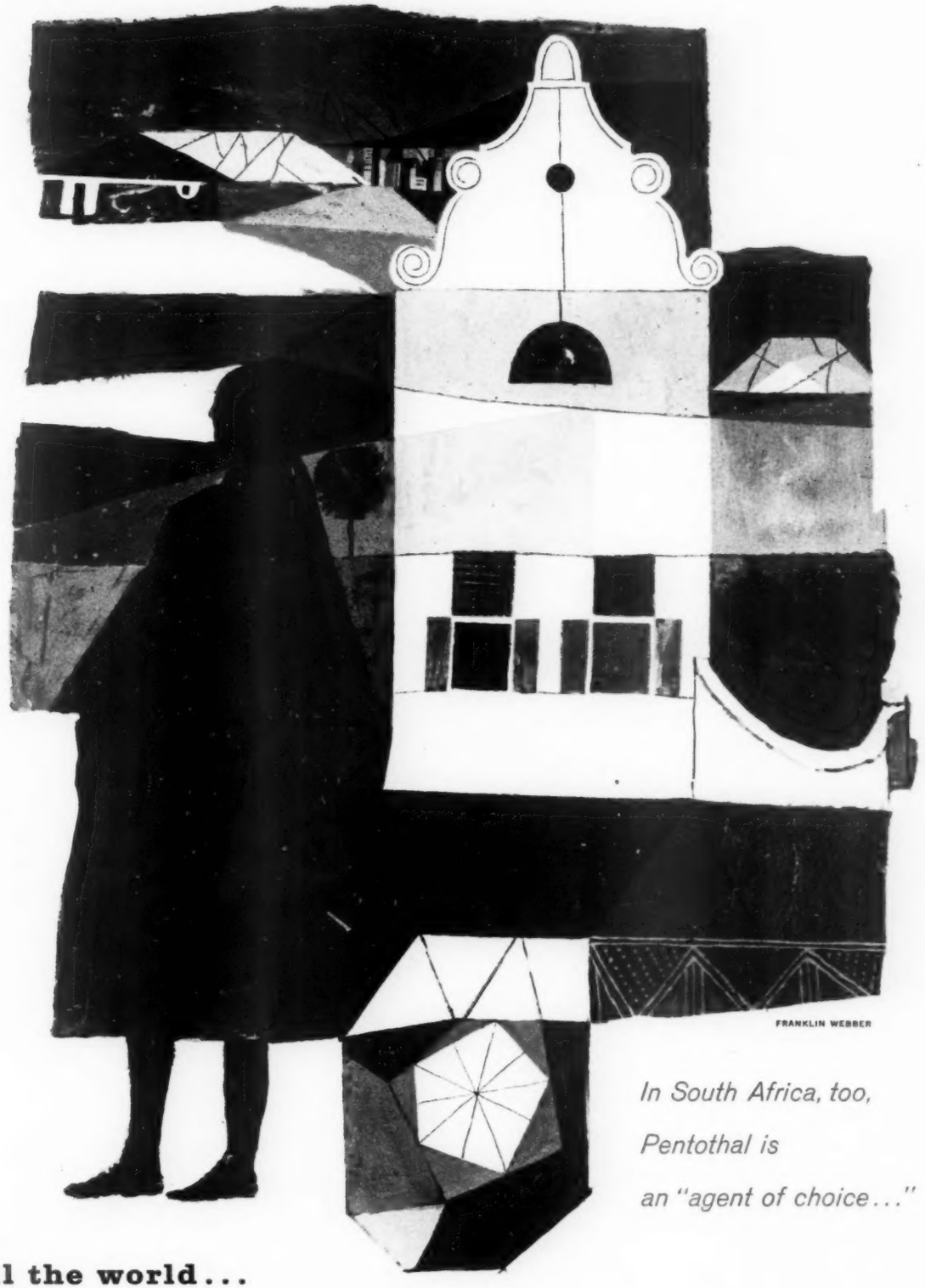

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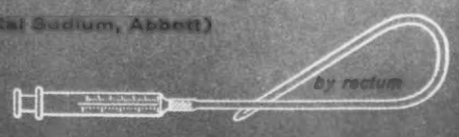

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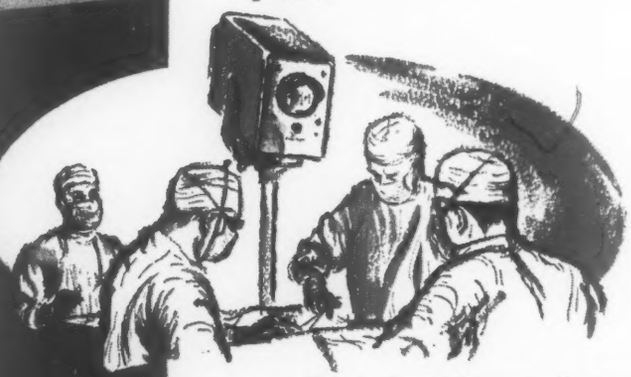

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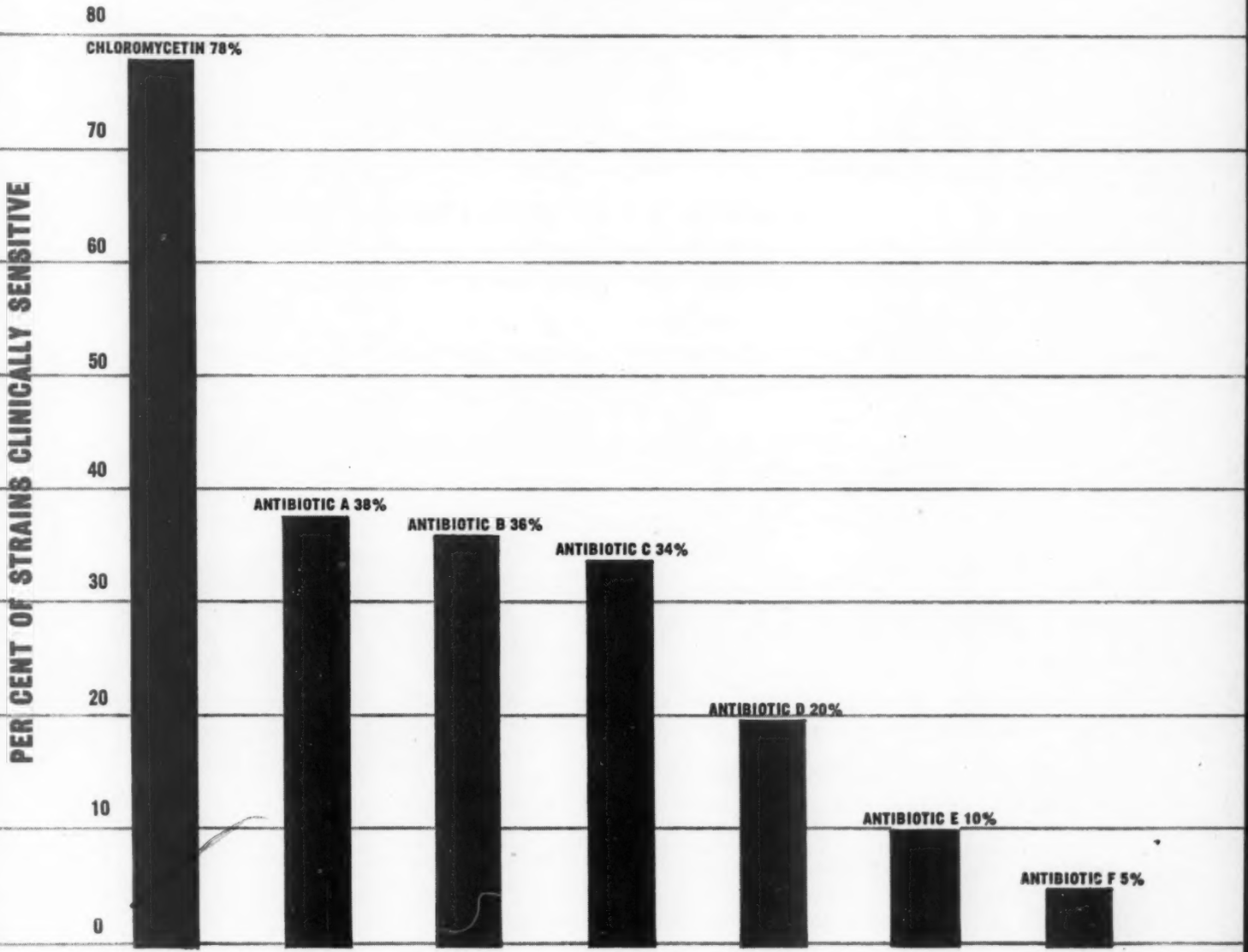

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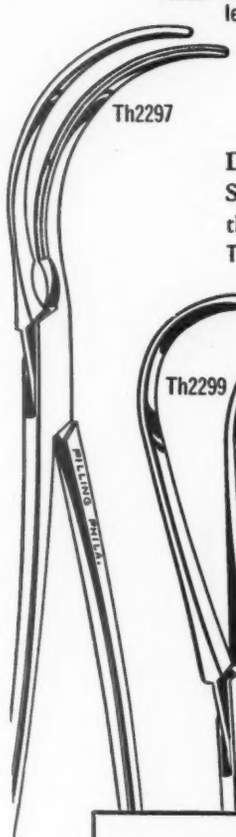

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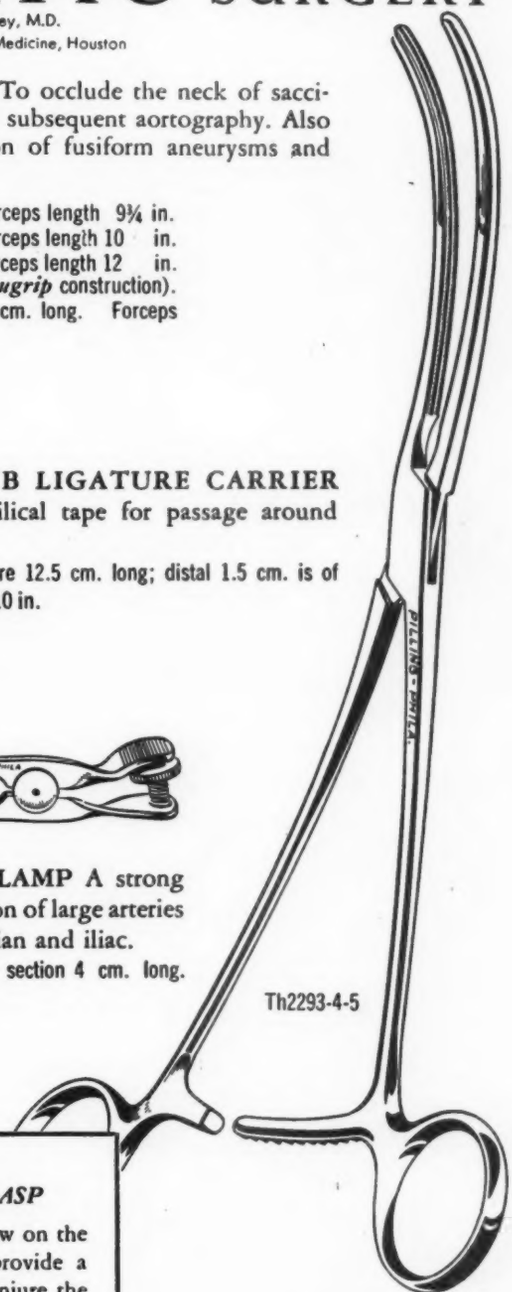

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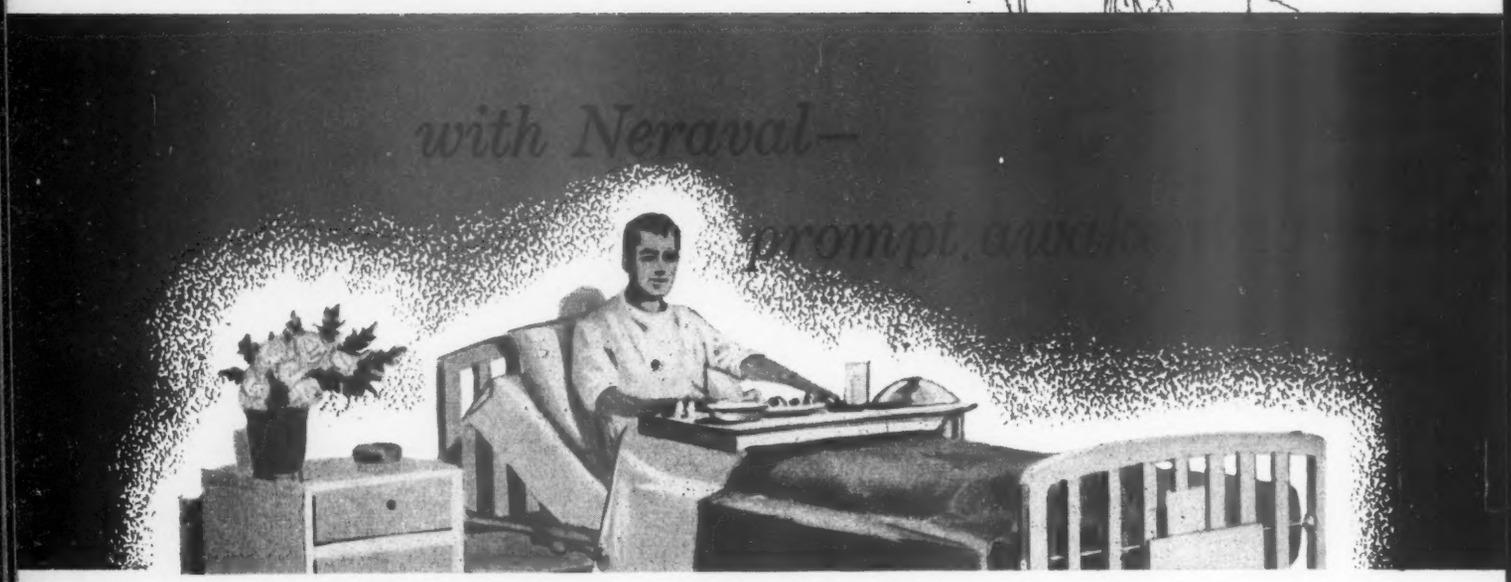

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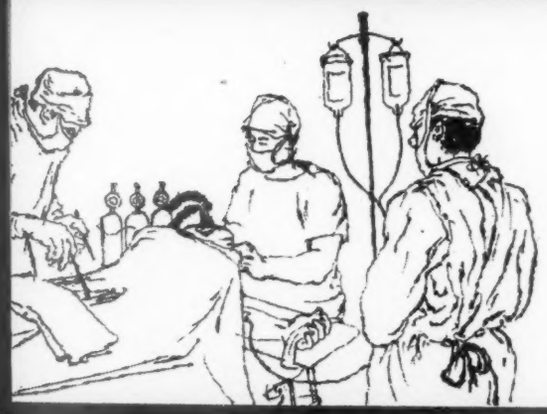

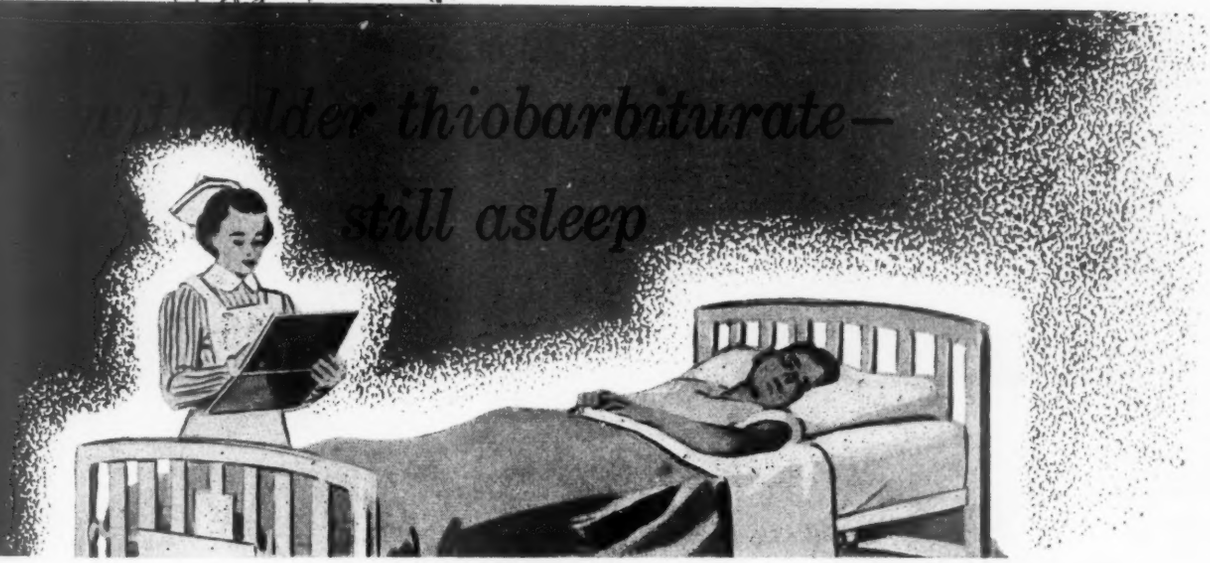

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(1) Boone, J. D.; Muñoz, R., and Dillon, J. B.: Anesthesiology *17*:284, 1956. (2) Zima, O.; von Werder, F., and Hotovy, R.: Anaesthesist *3*:244, 1954. (3) Mersch, M. A.; Clarie, D'A., and Fitzpatrick, L. J.: J.M. Soc. New Jersey *53*:414, 1956. (4) Blake, M. W., and Periman, P. L.: J. Pharmacol. & Exper. Therap. *117*:287, 1956. (5) Irwin, S.; Stagg, R. D.; Dunbar, E., and Govier, W. M.: J. Pharmacol. & Exper. Therap. *116*:317, 1956. (6) Ayd, F. J., Jr.: Neraval: A new anesthetic for electroconvulsive therapy, Paper presented at annual meet., Electroshock Research Association, Chicago, Illinois, April 29, 1956. (7) Reifferscheid, M., and Dietmann, K.: Deutsche med. Wchnschr. *79*:638, 1954. (8) Houde, J.; Hudon, F., and Jacques, A.: Neraval (methitural sodium), Paper presented at Meet., Canad. Anaesth. Soc., Quebec City, P. Q., May 5, 1956.

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The American Journal of Surgery

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EDITORIAL

When Do Patients Die?

A HOSPITAL is an institution that must spring to life at any time, and with little loss of time, while the rest of the city sleeps. Emergencies are routine in a hospital and its doors are never closed. Unfortunately, night facilities are not quite the same as day facilities in a hospital and even a little loss of time may sometimes be dangerous. During the night, attending physicians are usually at home. Laboratories, while they may be reopened, are all closed, as are x-ray facilities; administrative personnel is not available for occasional important decisions, and the nursing staff is reduced to a minimum. With all due respect to nursing staffs everywhere, it is not possible to watch patients as closely during the night as during the day. The simple fact that it is dark at night has on occasion proved dangerous for the critically ill patient.

All this means that patients have sometimes been unexpectedly found dead in their rooms at night; that blood pressure determinations are not done commonly at night; that laboratory tests and x-ray examinations are not obtained as quickly at night; and, what is even more important, that such tests and examinations are often put off for several hours simply because it is night.

With this in mind, all postoperative deaths occurring during the past four years at the Lincoln General Hospital, Lincoln, Nebraska, were investigated to see if any element of preventability existed. The study consisted solely of a listing of the eighty deaths according to: (1) the time of day, (2) the postoperative day of death, (3) the day of the week, and (4) the month.

The twenty-four-hour day was divided first into two parts, from 6 A.M. to 6 P.M. (day and night); second into two parts, from noon to midnight (A.M. and P.M.); third into the four six-hour quarters obtained from the first two divisions; and finally into three eight-hour periods representing nursing shifts or their equivalents. A death occurring exactly at an hour dividing two study periods is represented by a fraction in each time interval.

The first division (day and night) yielded almost identical values. The separation between A.M. and P.M. hours, however, produced what seems to be a significantly unequal division of the eighty cases; twenty-eight deaths occurred during the A.M. hours, while fifty-two patients died during the P.M. hours (approximately 35 and 65 per cent respectively). Quarter-day divisions gave no additional information.

Nursing shifts at the Lincoln General Hospital are 11 P.M. to 7 A.M., 7 A.M. to 3 P.M. and 3 P.M. to 11 P.M. The numbers of deaths for these periods are eighteen, twenty-seven and thirty-five (approximately 22, 34 and 44 per cent, respectively), so that the death rate was twice as high during one shift as during another. However, most of the P.M. deaths occurred early in the day, and dividing the day into the three eight-hour periods running from 9 P.M. to 5 A.M., 5 A.M. to 1 P.M. and 1 P.M. to 9 P.M. produced an even more uneven distribution; the deaths for these periods were 21.5, 19.5 and 39 (approximately 27, 24 and 49 per cent, respectively). Thus half the deaths occurred in one eight-hour period.

The postoperative day of death ranged from 0 to 167. The average obtained by adding the

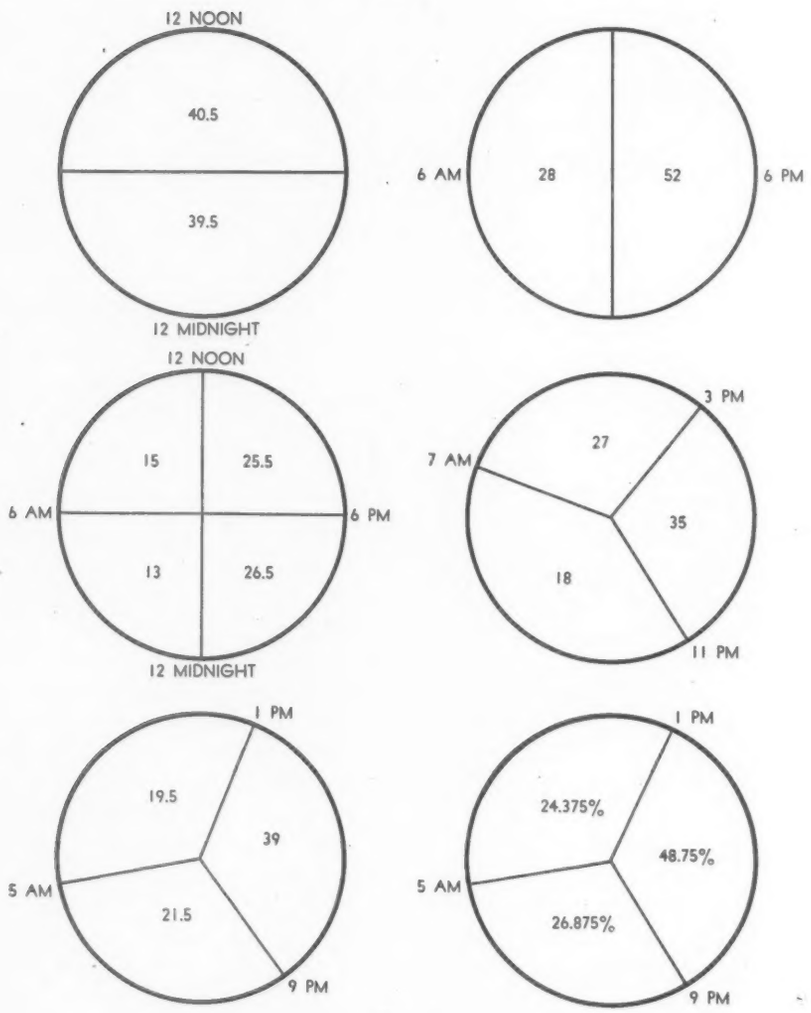

FIG. 1

days and dividing by eighty was 15.5, while the median was nine. The mode, which is thought to be most important statistically, was two; twelve of the eighty deaths occurred on the second postoperative day.

Although a study of the hourly occurrence of postoperative deaths showed that they were distributed unevenly throughout the day, it must be admitted that factors that were at first believed to be possible causes of unequal distribution appeared to play little or no part in this phenomenon (only 27 per cent of the deaths occurred during the one-third of the twenty-four-hour period between 9 P.M. and 5 A.M.); nor can any other cause be found to explain this event, unless it be that a hazard existing in one time period results in deaths in another, but this is mere conjecture.

In this series the most dangerous part of the day for the postoperative patient was the eight-hour period from 1 P.M. to 9 P.M.; there were approximately twice as many deaths on the nurses' 3 P.M. to 11 P.M. shift as on the 11 P.M. to 7 A.M. shift; and the most dangerous day proved to be the second day after surgery. The uneven hourly distribution of deaths appears somewhat startling, but no cause can be found for it. It was obvious that the curve illustrating the numbers of deaths on the various postoperative days would rise to a high level and then fall away toward a vanishing point; what was revealed in the second part of the study was the fact that this rise was associated with the second day following the operation, and that an extremely high peak was found here.

The eighty deaths were then grouped with regard to month and day, and the following distribution was obtained:

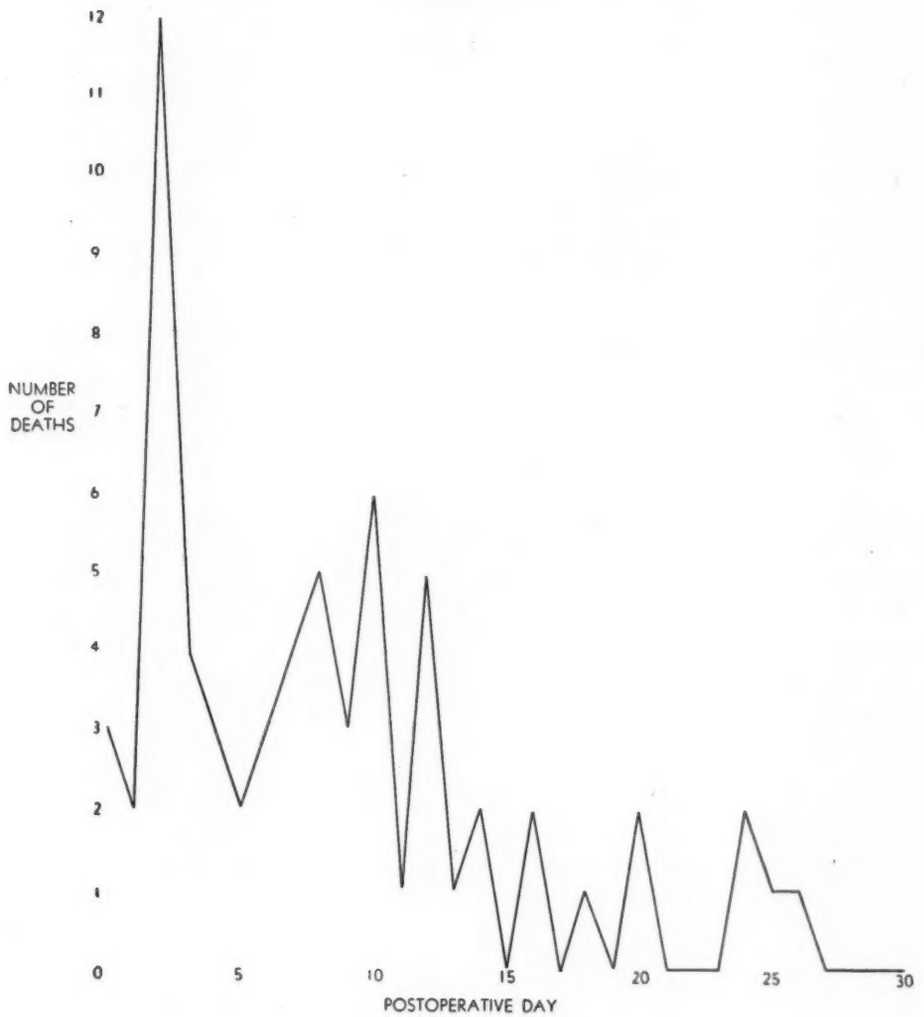

FIG. 2

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
5	6	7	6	9	7	5	7	6	11	7	4

Sun.	Mon.	Tue.	Wed.	Thurs.	Fri.	Sat.
8	11	12	13	6	16	14

The most dangerous month was October and the most dangerous day was Friday (the death rate for Friday and Saturday was 50 per cent higher than for other days), but these findings are not believed to be highly significant. Note, however, that the death rate for October (11 per month) is 75 per cent higher than that for the other eleven months (6.27 per month).

In conclusion, times of eighty postsurgical deaths were analyzed according to day of the week, month, hour of day and postoperative day. Little or no significant variation from chance-induced scatter was found for week-day or for month. Wide variations were found in the hourly occurrence of deaths following surgery in eighty consecutive cases; there was a tendency for postoperative deaths to be concentrated in the afternoon and evening hours, when the mortality rate was approximately twice that for all other times. The most common day associated with postoperative deaths was the second day after surgery. It is suggested that while others may or may not share these findings exactly, there would definitely appear to be a complete lack of random selection of the hour of death for the patient who has undergone surgery. Several theories are advanced but no proof or time relation is offered. Findings obtained in this study are illustrated in Figures 1 and 2.

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Lincoln, Nebraska

Partial Anomalous Venous Drainage

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From the Hahnemann Medical College and Hospital of Philadelphia. This work was supported by the Mary Bailey Foundation for Heart and Great Vessel Research, Philadelphia, Pennsylvania.

PARTIAL anomalous venous drainage may exist as an isolated entity, but more frequently it is accompanied by an atrial septal defect. In our series of over 100 cases of atrial septal defects in which operation was performed, seventeen were complicated by partial anomalous venous drainage. This frequent association has greatly facilitated their correction.

Closure of atrial septal defects by the external suture technic (atrioseptopexy) was first proposed and successfully applied by Bailey in 1952 [1]. Modification of this technic to divert the right pulmonary venous return through the septal defect into the left atrium was reported by Neptune et al. in 1953 [2]. Use of an atrial well was suggested by Gross et al. [3] for the surgical correction of these defects. In a recent publication, however, Gross and Watkins [4] have recommended the adoption of the simpler closed external suture technic as described heretofore. The relative merits of the different methods have been discussed by Kirklin et al. [5].

During the past four years twenty-two cases of partial anomalous pulmonary venous drainage have been corrected by our group. These cases form the basis of this report.

PATHOLOGIC PHYSIOLOGY

Patients having anomalous pulmonary venous drainage may be divided into two groups, i.e., those with and those without associated septal defect. The septal defect is most frequently manifested as a posterior secundum type anomaly. The location of these defects in close proximity to the anomalous vein mouths suggests that the formation of the septum in this region (during embryonic life) may have been impaired by the direct trans-septal flow of blood from these veins [6]. The existence of an intact atrial septum with anomalous veins is infrequent. In our series there were only five cases, and in one of these there was a patent foramen ovale.

Anatomically, veins from the left lung may drain into the left innominate vein, into a persistent left superior vena cava, or into the coronary sinus. This blood may be returned to the right atrium by way of a communicating right superior vena cava, or by the coronary sinus. From the right lung, in our series, veins were found to enter directly into the right atrium, one of the cavae, or some combination of these.

These anomalies, particularly when associated with an atrial septal defect, place an additional load upon the right heart and pulmonary bed, tending eventually toward the development of pulmonary hypertension and cardiac failure. The symptoms and physical findings associated with these venous developmental errors are identical with those seen in atrial septal defects. The plain roentgenogram of the chest may supply a clue to the type of anomalous drainage present [7]. Peripheral

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† This work was done during the tenure of a National Heart Institute Traineeship at the Hahnemann Medical College and Hospital of Philadelphia.

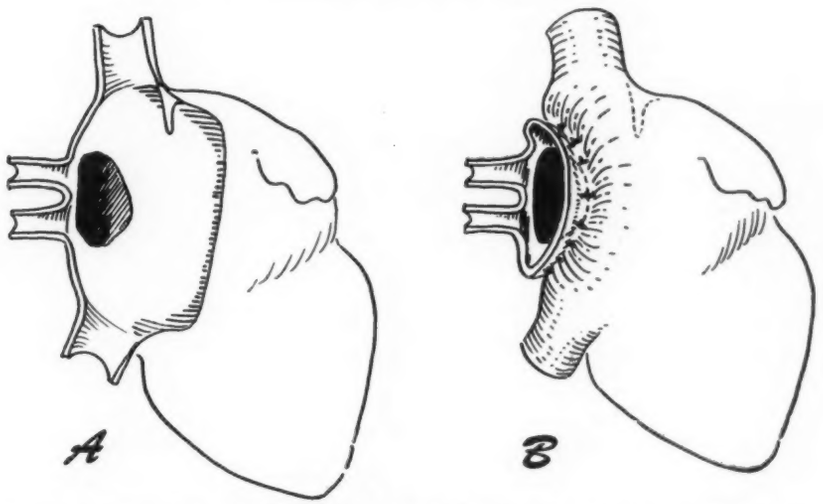

FIG. 1. *A*, a posterior atrial septal defect is illustrated. The right pulmonary veins are shown entering the right atrium.

B, the right atrial wall is sutured to the anterior margin of the septal defect. The right pulmonary venous blood is diverted into the left atrium.

arterial unsaturation and cyanosis are found only in the presence of a right-to-left shunt through an atrial septal defect and are late signs, except in instances of total anomalous pulmonary drainage. Angiocardiography may be used in this group to confirm the presence of the atrial defect, but adds little in the demonstration of anomalous veins. Cardiac catheterization is of greater value, inasmuch as the catheter may be passed directly into an anomalous pulmonary vein. If it empties into the superior vena cava, one can establish the presence of anomalous venous drainage by a rise in the level of oxygen saturation of a blood sample obtained at this level. A septal defect may allow the passage of a catheter into a normal pulmonary vein. Hence the differential etiology of a left-to-right shunt at the mid-atrial level cannot be determined with certainty by this method of study or by dye dilution curves. If the catheter has been guided into an anomalous vein, this can be demonstrated by injecting 70 per cent diodrast® into it. Passage of the catheter through the septal defect into the left ventricle, or into a persistent left superior vena cava, also may give positive information. Multiple blood samples may aid in localizing the level of a left-to-right shunt.

The ultimate and only completely accurate method of diagnosis, when the shunt is at the atrial level, is by digital exploration of the atrial chambers. When the surgeon is faced with the correction of an atrial septal defect, he must be prepared to recognize and treat any coexistent anomalous pulmonary veins. The frequent association of the two abnormalities makes this mandatory.

CLASSIFICATION

Since 1952 twenty-two patients with partial anomalous pulmonary venous drainage have been treated. After a review of our cases it became apparent that they fell into well defined groups.

Group 1. Interatrial septal defect with anomalous right pulmonary venous drainage directly into the right atrium (eleven cases). (Fig. 1*A*.)

Group 2. Interatrial septal defect with anomalous drainage into the superior vena cava alone or with additional veins entering the right atrium (six cases). (Fig. 2*A*.)

Group 3. Right partial anomalous venous drainage without atrial septal defect (two cases). (Figs. 3*A* and 4*A*.)

Group 4. Left partial anomalous venous drainage without atrial septal defect (two cases). (Fig. 5*A*.)

Group 5. Partial right and partial left combined without atrial septal defect (one case). (Fig. 6*A*.)

SURGICAL MANAGEMENT

It becomes obvious that no one type of repair is appropriate in all cases of anomalous

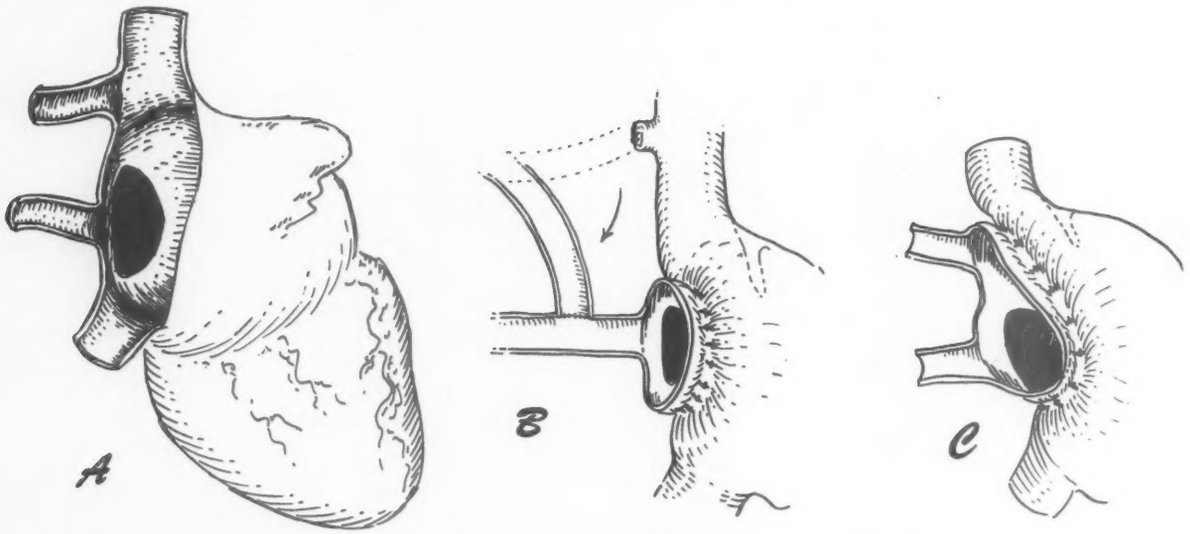

FIG. 2. *A*, the superior pulmonary vein is shown entering the superior vena cava. The inferior vein empties directly into the right atrium.

B, the superior vein is attached end-to-side to the inferior vein. Right pulmonary venous return is shunted to the left atrium by atrioseptopexy.

C, the anomalous superior vein is shunted into the left atrium by constructing two venous channels from the superior vena cava. This is done by placing mattress sutures in an anteroposterior fashion, as illustrated.

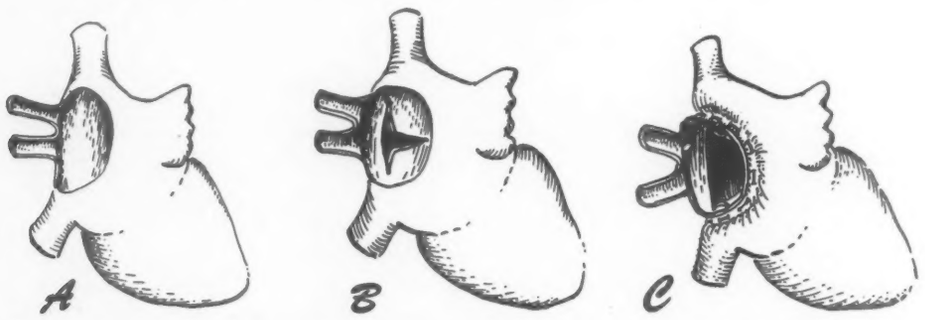

FIG. 3. *A*, demonstration of anomalous venous drainage of the right pulmonary veins into the right atrium. Note the absence of an atrial septal defect.

B, a septal incision is made posteriorly, adjacent to the mouths of the pulmonary veins. The opening is enlarged to allow an adequate opening for the right pulmonary venous blood.

C, correction of the anomaly is completed by the modified technic of atrioseptopexy.

drainage. Each of the groups requires a specifically designed technic.

Cases in group 1 lend themselves readily to correction by suturing that portion of the right atrial wall into which the anomalous veins drain to the free margin of the interatrial defect, thus isolating the veins from the right atrium and shunting their blood into the left atrium. This is, in reality, a pure atrioseptopexy, the only modification being that the portion of the right atrial wall which is chosen to suture over the interatrial defect is that through which the anomalous veins empty. (Fig. 1*B*.)

Group 2 is a somewhat more complex surgical problem. Two avenues of attack may be used, depending on the abnormality present. If the situation is such that one vein enters the superior vena cava and one enters the right atrium, it may be feasible technically to anastomose the vein entering the superior vena cava to the one draining into the right atrium. Then this would be followed by correction by the technic of atrioseptopexy as in

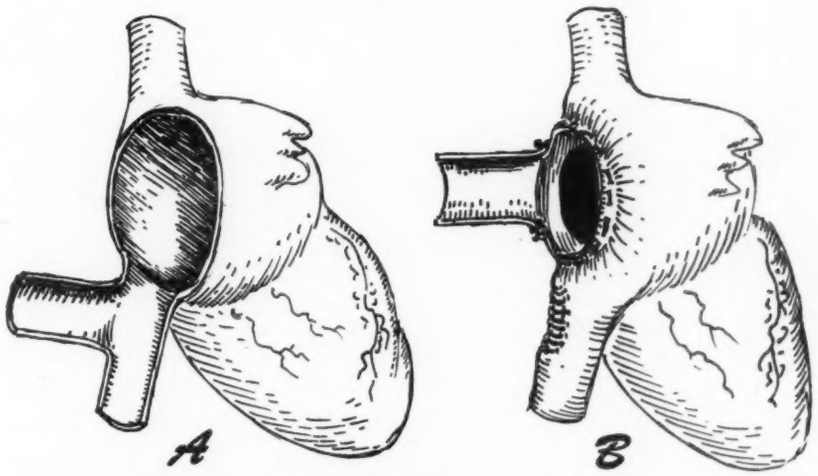

FIG. 4. *A*, total right pulmonary venous drainage into the inferior vena cava is shown, with no associated septal defect.

B, the anomalous vein is anastomosed to the right atrium, an atrial septal defect is created and the drainage switched to the left atrium by atrioseptopexy.

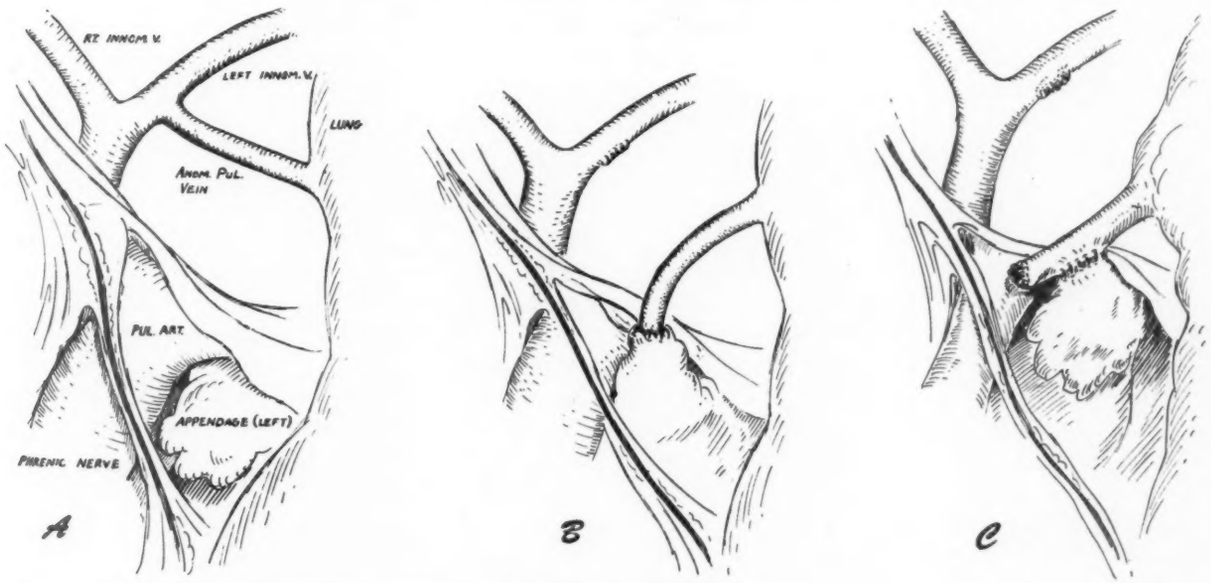

FIG. 5. *A*, an anomalous pulmonary vein enters the left innominate vein.

B, the anomalous vein is shown anastomosed to the left auricular appendage.

C, the alternative method which is preferable, inasmuch as a wider opening is formed and circulation need not be interrupted. Side-to-side anastomosis of the left pulmonary vein to the appendage; then the vein is detached from the caval system.

group 1. (Fig. 2*B*.) However, if the drainage of the right lung is totally into the superior vena cava or it is technically impossible to anastomose the aberrant vein or veins to one already draining into the right atrium, an alternative method may be used. By dividing the superior vena cava with mattress sutures into two conduits, the anomalous vein and part of the vena cava may be converted into a tube draining into the right atrium. (Fig. 2*C*.) The flow then may be directed into the left atrium by the modified atrioseptopexy procedure.

In group 3, when right-sided anomalous pulmonary venous drainage is not associated with an atrial septal defect, it appears that two

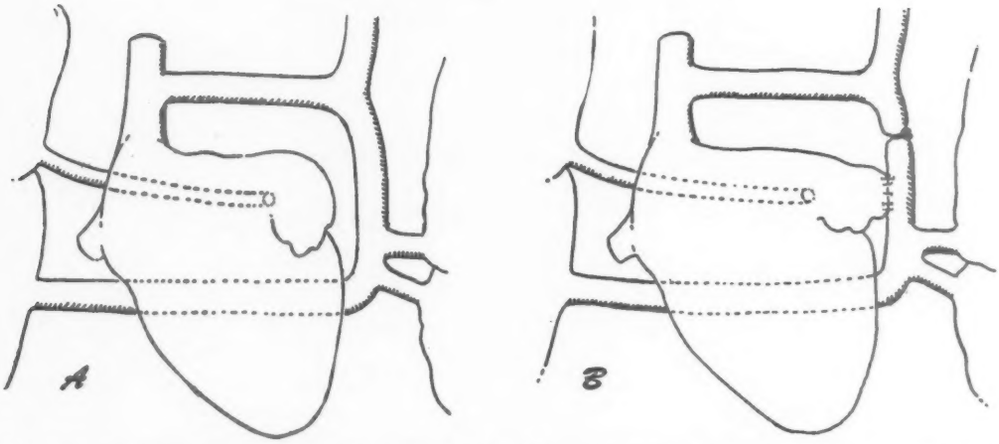

FIG. 6. *A*, pulmonary venous drainage from the right lower lobe and the entire left lung entered the right atrium through a persistent left inferior vena cava. There was no septal defect.

B, surgical correction was accomplished only partially because of the small size of the stoma which was created.

avenues of treatment exist: (1) Anastomose the abnormally draining pulmonary vein to one entering normally into the left atrium. This approach would not be feasible if both veins from the right lung were draining into the right atrium. (2) Anastomose the vein directly to the left atrium. This is impossible if the vein is not long enough or if the left atrium is inaccessible. Unfortunately, this often holds true. In our two cases, neither of the foregoing technics was feasible. It was thought that if an interatrial septal defect were created, the new combination of lesions could be handled by the technic of atrioseptopexy. In the first case the drainage was totally into the right atrium. Accordingly, a conveniently located interatrial septal defect was created and the drainage of the right lung was diverted to the left atrium by the modified atrioseptopexy procedure. (Fig. 3*B* and *C*.) In the second case there was one short, large diameter, single vein draining into the inferior vena cava from the lower and middle lobes, and only one very small vein from the upper lobe emptying into the left atrium. Because of the disparity in size and the short length of the anomalous vein, it could not be anastomosed to the normally draining vein. Accordingly, it was detached from the inferior vena cava and anastomosed to the right atrium. An interatrial septal defect was created, and the drainage of the vein was directed through the interatrial defect into the left atrium by the technic of atrioseptopexy. (Fig. 4*B*.)

The use of pneumonectomy or lobectomy in the treatment of these cases has been reported but would seem to be an unnecessary sacrifice of normal lung tissue.

Group 4 represents two cases of anomalous pulmonary venous drainage into the innominate vein with no septal defect present. However, one patient had a patent foramen ovale. These cases were handled simply by detaching the innominate junction and making an anastomosis directly to the left auricular appendage. This may be done by an end-to-end anastomosis between the vein and left appendage (Fig. 5B) or, because a larger opening can be obtained, by a side-to-side anastomosis of the vein to the left atrial appendage. (Fig. 5*C*.)

Group 5 represents one case of partial bilateral anomalous venous drainage. All the left pulmonary veins and the inferior right pulmonary vein drained through a persistent left superior vena cava into the right atrium. An anastomosis was created between the left auricular appendage and the side of the left superior vena cava. Ligation of the cava was then carried out above the site of entry of the left superior pulmonary vein. This was not tolerated well due to the small size of the created stoma. In view of the patient's critical condition at that moment, the vena caval lumen was obliterated only three-fourths by partial ligation. (Fig. 6*B*.) An uneventful recovery ensued, and the child is now undergoing normal development with no symptoms. Complete interruption of the persistent left

superior vena cava may be considered if the clinical condition deteriorates in the future.

POSTOPERATIVE RESULTS

In order to assess the value of an operative procedure, postoperative evaluation is necessary. As the surgical technic has evolved only since 1952, the period of observation is relatively short. Nevertheless, a review of the available data is presented to evaluate the procedure.

The clinical follow-up ranges from three to thirty-six months, with an average period of fifteen months. There were four postoperative deaths. This left eighteen patients available for study.

It is interesting that two of these patients had concomitant mitral stenosis in addition to anomalous pulmonary venous drainage. One was associated with left anomalous drainage alone, the other with a septal defect. The mitral stenosis was corrected simultaneously with the other defects.

For the sake of standardization, it was thought advisable to group these patients according to the American Heart Classification pre- and postoperatively. (Table I.)

Table I

Preoperatively		Postoperatively				
Classification	No. of Patients	Classification				Died
		I	II	III	IV	
I	0	..	..	..	..	..
II	7	7	..	..	..	..
III	11	6	3	..	..	2
IV	4	1	1	..	..	2
Totals	22	18				4

Seven patients preoperatively in class II are now in class I. Of the nine living patients in class III, six are in class I and three are in class II. Of the two survivors in class IV, one is now in class II and one in class I.

It is noteworthy that in the clinical response no patient remained in the preoperative class. All eighteen were improved and were able to return to a more normal life.

The remarkable incidence of improvement can be attributed to the fact that the patients had a congenital abnormality and not true intrinsic "cardiac disease." If the defect is corrected, the patient should return to a nearly normal cardiac status, unlike those with rheumatic heart disease who may still have the stigmas of valvular and myocardial involvement.

Pre- and postoperative cardiac catheterization studies were available on thirteen of the patients. Preoperative left-to-right shunts from 1 to 20 L. per minute were demonstrated, while postoperatively no residual shunt was revealed in any case.

In this series there were four operative deaths and no late deaths. Two of these deaths were from class III, and two were from class IV. One of these patients was in marked congestive failure preoperatively, and after intensive medical therapy was brought to surgery as his only hope of prolonged survival. In a second patient, an infant, pulmonary edema developed when clamps were placed across the anomalous pulmonary veins, and the infant died in the immediate postoperative period. Probably this complication could have been obviated by performing an anastomosis between the appendage and the side of the vein before interrupting the continuity of the latter. The two other patients who did not survive (class III) had septum primum defects. Both patients were cared for early in our experience, before the enormity of the problem of the septum primum defects was fully appreciated. In our present stage of development, we would correct this type of defect with the aid of the extracorporeal pump oxygenator system.

At the present time we do not believe that either the mechanical pump oxygenator systems or the use of hypothermia have a place in the surgery of partial anomalous pulmonary venous drainage occurring either as an isolated lesion or along with associated defects of the septum secundum type. We believe that the closed technic of atrioseptopexy is a much better method of management than either the open or the "well" technics with the use of ivalon* sponge prosthesis.

SUMMARY

1. Twenty-two cases of partial anomalous venous drainage are discussed.

* Obtainable from Davis & Geck, Danbury, Conn.

2. A clarification of the various types is offered.

3. The principle of surgical correction is described in detail.

4. The results of the use of the modifications of atrioseptopexy are evaluated.

Acknowledgment: All the catheterization and other physiologic data were supplied by Dr. Harry Goldberg, Director, Brith Sholom Cardiopulmonary Laboratory, Hahnemann Medical College and Hospital of Philadelphia, Philadelphia, Pennsylvania.

REFERENCES

1. Bailey, C. P., Downing, D. F., Geckeler, G. D., Likoff, W., Goldberg, H., Scott, J. C., Janton, O. and Redondo-Ramirez, H. P. Congenital interatrial communications: clinical and surgical considerations with a description of a new surgical technique: atrio-septo-pexy. *Ann. Int. Med.*, 37: 888, 1952.
2. Neptune, W. B., Bailey, C. P. and Goldberg, H. The surgical correction of atrial septal defects associated with transposition of the pulmonary veins. *J. Thoracic Surg.*, 25: 623, 1953.
3. Gross, R. E., Pomeranz, A. A., Watkins, E. and Goldsmith, E. I. Surgical closure of defects of the interauricular septum by the use of an atrial well. *New England J. Med.*, 247: 455, 1952.
4. Gross, R. E. and Watkins, E. Surgical closure of atrial septal defects. *Arch. Surg.*, 67: 670, 1953.
5. Kirklin, J. W., Ellis, F. H. and Wood, E. H. Treatment of anomalous pulmonary venous connections in association with interatrial communications. *Surgery*, 39: 389, 1956.
6. Bailey, C. P. Surgery of the Heart, p. 333. Philadelphia, 1955. Lea & Febiger.
7. Bruwer, A. J. Postero-anterior chest roentgenograms in two types of anomalous pulmonary venous connection. *J. Thoracic Surg.*, 32: 119, 1956.

Arterial Homografts

EXPERIENCE WITH END-TO-SIDE VASCULAR ANASTOMOSIS

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UNQUESTIONABLY one of the most significant advances in surgery in recent years has been the development of arterial grafting procedures to replace or bypass vessels obliterated by atherosclerosis. In this period when we are becoming increasingly aware of geriatric problems, this is one field in which great benefits can be derived from relatively simple procedures.

There has been sufficient experience with arterial homografts to indicate that they can be handled well technically in almost any location, and they have stood the test of time with a minimum of deterioration and aneurysmal formation. Synthetic materials are showing great promise and may even surpass homografts in some qualities [*6*].

Obliterative disease is, of course, only one of several conditions affecting the aorta and peripheral arteries that can be relieved by grafting. Others are aneurysms, thromboses, arterial injuries with complete division, congenital and vascular lesions, and tumors situated near major arteries in which part of the vessel must be removed in order to secure adequate resection. By far the most common indication, however, is obliterative disease secondary to atherosclerosis. Because of an inadequate blood supply to the buttocks, thighs, legs and feet, these individuals develop progressive intermittent claudication, rest pain and eventually ischemic ulcers and gangrene. The primary reason for re-establishing arterial continuity in these patients is to restore the muscular function of the extremity by improving its arterial blood supply. Procedures such as lumbar sympathetic ganglionectomy have proved of little value in this symptom complex because they do not augment the blood supply to the muscles sufficiently [*5*]. The only satisfactory method of treatment of this disease is to restore a column of arterial blood sufficient to meet the metabolic needs of the extremity, either by replacement of or shunting around the obliterated proximal segment. The vessels most amenable to this procedure are the aorta distal to the renals, the iliac, femoral and popliteal arteries. Until recently it was thought that resection of the obliterated arterial segment with replacement by homologous graft with end-to-end anastomosis was the preferred technic. However, following the pioneer work of Kunlin with venous autografts, later modified by Cockett for arterial homografts, the technic of end-to-side anastomosis has proved technically easier to accomplish and has a much higher incidence of graft patency [*1,5*]. Linton and Menendez [*5*], in a recent comparison of long term results with vascular anastomosis, found that only 40 per cent of their end-to-end grafts remained patent while 80 per cent of their end-to-side grafts remained so. This was ascribed to the more difficult technic, particularly when endarterectomy had been done to assure sufficient pliable tissue for the end-to-end anastomosis; it was also attributed to the inevitable narrowing of the anastomotic site. Conversely, end-to-side anastomoses are made actually larger than the lumen of the vessel and may be placed in a soft, pliable area of the host artery [*5*]. Anastomosis may be placed at the optimum level for blood flow without sacrificing essential collaterals [*1*]. In the event the graft should thrombose, the patient's condition is no worse than it was preoperatively. How-

FIG. 1. Case 1. Preoperative left femoral arteriogram showing obliterated segment of superficial femoral artery.

ever, with end-to-end anastomosis he may very well lose an extremity. The technic used in this series is essentially that described by Linton [4]. A section of host artery with a soft, pliable area approximately 3 to 4 cm. in length is isolated between two blood vessel clamps. A longitudinal incision is made into the lumen of the vessel, the length ranging from two to three times the diameter of the host artery, and should avoid any atheromatous plaques. The end of the homograft should then be cut straight across. A longitudinal slit is made from the cut end, equal in length to the incision in the host artery. The squared corners are rounded off. The proximal and distal ends of this ellipse are then secured to the respective ends of the incision in the host artery with everting horizontal mattress sutures of No. 5-0 arterial silk. The anastomosis is completed by suturing the sides of the graft to the sides of the incision in the host artery with simple over-and-over suture, utilizing the needle ends of the previously placed mattress sutures. This produces a funnel-like opening between the host artery and graft; and as the sutures go only part way around the circumference of the host artery, most of this wall is free to distend.

Five cases of end-to-side anastomosis are reported in this series: one bifurcation graft, aorta to external iliacs bilaterally; one external iliac to popliteal; one common femoral to superficial femoral; and two common femoral to popliteal.

CASE REPORTS

CASE 1. W. O., a sixty-six year old diabetic Negro man was admitted to the Veterans Administration Center, Jackson, Mississippi, with the chief complaint of burning pain of the left foot which was particularly severe at night. For two or three months prior to admission he had had gradually increasing intermittent claudication involving the left lower extremity. Examination revealed a well developed, well nourished Negro man who was cooperative and oriented, and did not appear acutely ill. The blood pressure was 170/80. A grade II systolic murmur was noted at the aortic area, radiating to the neck. The prostate was 2 plus enlarged. There was edema of the distal half of the left foot and toes, with discoloration of this area and beginning gangrene of the left fourth toe. There was absence of dorsalis pedis, posterior tibial and popliteal pulsations on the left. Dorsalis pedis, posterior tibial and popliteal pulsations on the right were present but diminished. There were good femoral pulsations bilaterally. X-ray examination of the chest revealed increased prominence of the mediastinal shadow just opposite the aortic arch. There was a small calcific plaque in the arch of the aorta. The prominence of the mediastinal shadow suggested aneurysm. Lung fields were clear. Cardiac fluoroscopy confirmed the presence of a saccular aneurysm of the ascending aorta. Electrocardiogram was normal, with premature ventricular contractions. X-rays of the feet showed absorption of the tufts of the terminal phalanges of most of the toes bilaterally. On the left there was a slight absorption of a portion of the shafts of the middle phalanges of the fourth and fifth toes. There was no evidence of osteomyelitis. VDRL was positive with titer 1; complement fixation was doubtful. Urinalysis showed 1 plus sugar, rare

FIG. 2. Case 1. Bypass graft in place showing technical details of the end-to-side anastomosis. Although this graft has remained patent and has functioned perfectly, it is too long. Grafts actually should be sutured under slight tension.

red blood cells. The hemoglobin was 12 gm. per cent. The white blood cell count was 5,700 per cu. mm., with normal differential. The fasting blood sugar was 111. The patient remained essentially afebrile. The left extremity was treated conservatively with priscoline® and bed rest; aspirin and codeine were required for pain. There was no improvement of the gangrene of the fourth toe. The patient was given an 1,800 calorie A. D. A. diet and his diabetes remained controlled without the use of insulin. A left femoral arteriogram was taken on July 9, 1956, which revealed an obstruction of the superficial femoral artery approximately 3 inches in length. (Fig. 1.) The patient was transferred to the Surgical Service, and on July 23rd the area was bypassed with a homologous arterial graft using the end-to-side technic. (Fig. 2.) The graft measured 20 cm. in length. The patient did well postoperatively but never demonstrated a palpable dorsalis pedis or posterior tibial pulsation on the left. He did have objective and subjective improvement in the left foot and leg, manifested by warmth in this extremity and a decrease in pain. On August 7th the left fourth toe was amputated at the metatarsal-phalangeal joint. On August 13th a repeat left femoral arteriogram showed that the bypass graft was patent. (Fig. 3.) On August 15th, because of some continuing pain in the left foot, a left lumbar sympathetic ganglionectomy was accomplished. The patient has since been discharged from the hospital. The area of amputation of the left fourth toe is completely healed and he complains of only minimal pain in the left foot. Intermittent claudication has completely disappeared.

Comment. This short segment of obliterated superficial femoral artery constituted an ideal situation for a bypass graft. Although the patient had gangrene of the left fourth toe on admission, the circulation to the extremity was improved to such an extent that digital amputation of the fourth toe could be accomplished with healing, whereas without grafting he would have most surely required an above-the-knee amputation of the left leg. This graft was done early in our experience. We now believe that the graft is too long, making it tortuous, redundant and theoretically more apt to thrombose. We believe that shunt grafts should

FIG. 3. Case I. Left femoral arteriogram taken three weeks postoperatively showing patency of graft and large anastomotic channels.

FIG. 4. Case III. Preoperative left femoral arteriogram showing obliteration of the superficial femoral artery from its origin to within 4 cm. of popliteal artery.

be as short as possible to bridge the occlusion and should actually be sutured under slight tension.

CASE II. J. L. P., a fifty-two year old diabetic Negro man, was admitted to the Veterans Administration Center, Jackson, Mississippi, on June 29, 1956, complaining of sharp, shooting pains in the right calf extending down to the right foot. Pain was worse at night and seemed to disappear in the morning. He also had noticed progressively increasing intermittent claudication involving the right calf over a two-year period. Examination revealed a well developed, well nourished Negro man in no acute distress. There were decreased peripheral pulsations in both lower extremities. A small epigastric hernia was present just superior to the umbilicus; there was also a left indirect inguinal hernia. The skin of the right calf and right foot was darker in color than that on the left. Both feet were cool. There was no difference in temperature between the two lower extremities. Urinalysis on three occasions showed 1 plus albumin with microscopy showing granular casts, white blood cells, red blood cells, mucous threads and epithelial cells. Blood glucose was 100 mg. per cent; blood urea nitrogen was 14.8 mg. per cent. The white blood cell count was 11,300 per cu. mm. with normal differential. Two-hour postprandial glucose was 133 mg. per cent. Serology was negative. X-ray of the chest revealed no abnormalities. Right femoral arteriogram on July 10th revealed complete obstruction of the superficial femoral artery from its bifurcation to the popliteal. The profunda femoris was visualized and showed extensive collateral circulation throughout the thigh. Electrocardiogram showed left ventricular enlargement and

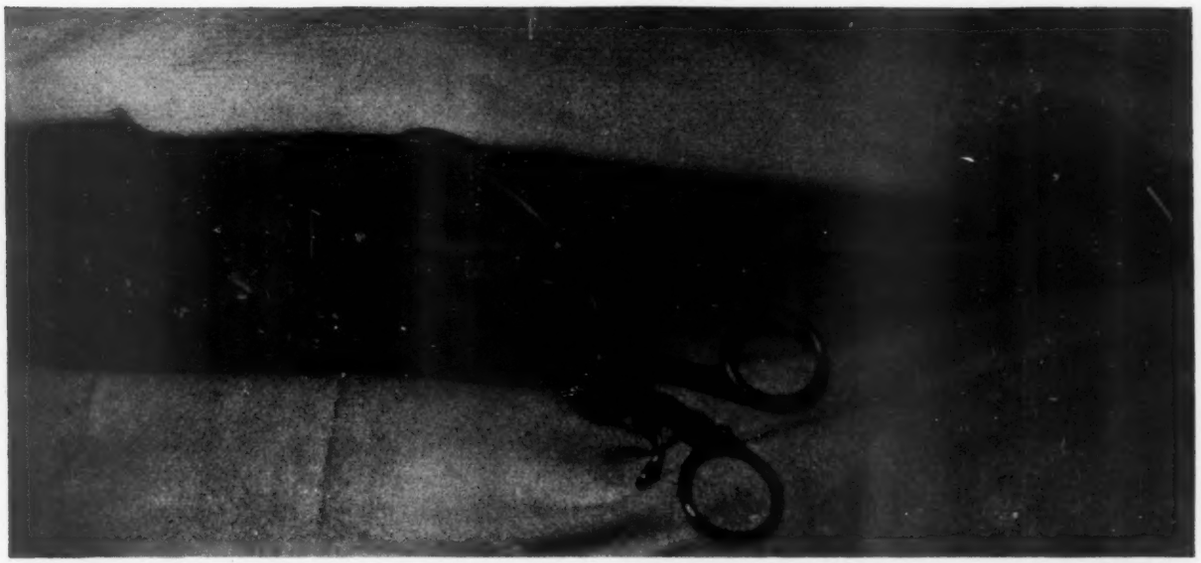

FIG. 5. Case III. Shows long (35 cm.) femoral arterial homograft in place. End-to-side anastomosis accomplished to the common femoral and popliteal arteries. This graft has been placed under the correct amount of tension so there is no tortuosity. The more prominent anastomosis is to the popliteal.

myocardial changes. On August 8th a homologous arterial bypass graft was placed from the common femoral to the popliteal. Endarterectomy had to be performed in the popliteal artery in order to secure an area to implant the graft. An arteriogram taken at the operation revealed patency of the anastomosis but marked narrowing of the peripheral vessels distally. The patient's right leg and foot became much warmer postoperatively and he became completely asymptomatic. However, symptoms recurred suddenly about two weeks postoperatively and a repeat arteriogram revealed complete block of the graft. A right lumbar sympathetic ganglionectomy was then performed. The right foot has remained warmer than the left. However, the patient still continues to complain of a small amount of pain involving the plantar surface of the right foot. There has been moderate improvement in intermittent claudication.

Comment. In retrospect, this patient probably represents the type who cannot be benefited by arterial grafting procedures because of generalized atherosclerotic involvement of the small peripheral vessels. The wall of the popliteal artery contained circumferential atheromatous plaques, necessitating endarterectomy to implant the graft for end-to-side anastomosis. This should have been our clue that the graft would not remain patent due to the marked atherosclerosis of the distal vessels.

CASE III. O. E. Y., a sixty-three year old white man, was admitted to the Veterans Administration Center, Jackson, Mississippi, on August 2, 1956, complaining of progressively increasing intermittent claudication involving both lower extremities for two years. Originally this sensation was one of weakness in the calves, but later cramping pain developed which was severe enough to make him stop walking. There was an associated sensation of burning on the plantar surfaces of the feet. Recently he had noticed weakness in the thighs and, fearing that the condition was extending upward, he came to the hospital. The preceding winter he had become aware that his feet became unusually cold and he had also begun having nocturnal cramps which would waken him from sleep. His general condition had remained good but he had to discontinue farm work because of bilateral leg pain. Examination revealed a slightly obese, elderly white man with a somewhat rolling gait which he stated was due to the fact that his calves hurt when they were stretched. The ocular fundi revealed mild tortuosity with irregularity and increased light reflex of the arterioles. There was absence of popliteal, dorsalis pedis and posterior tibial pulsations bilaterally. Femoral pulsations were present and of good quality. Both lower extremities became pale on elevation, with rubor and then cyanosis with dependency over a period of about three

FIG. 6. Case III. Postoperative arteriogram showing distal anastomosis to popliteal artery and patency of vessels below.

minutes. Both feet were cool, but of approximately the same temperature. The white blood cell count, differential, hemoglobin, urinalysis and serology were normal. Chest x-ray was normal. X-rays of the legs revealed calcification along the course of the posterior tibial vessels. Bilateral femoral arteriograms were taken on August 20th. On the left the superficial femoral artery could not be seen from its bifurcation distally for about 10 inches, after which the lumen of the superficial femoral was seen and appeared to be of practically normal caliber. (Fig. 4.) On the right there was failure of visualization of the superficial femoral artery beginning at the bifurcation and extending distally for a distance of 8½ inches, at which point a rather narrow lumen was seen extending distally for 1½ inches, following which the lumen widened to its normal caliber. The findings were considered compatible with arteriosclerotic obliteration of a large proximal segment of both superficial femoral arteries. The patient was treated conservatively with priscoline, bed rest and lumbar sympathetic blocks, without relief. He was transferred to the Surgical Service, and on September 10th, exploration revealed complete obliteration of the left superficial femoral artery. An arterial homograft was used to shunt this obliterated area, implanting the proximal end to the side of the common femoral artery and the distal end to the side of the popliteal artery. (Fig. 5.) The length of this arterial homograft was 35 cm. There was free flow of blood through the homograft at the time of anastomosis. An arteriogram, taken while the patient was on the operating table, revealed a free flow of opaque media through the shunt with good visualization of the peripheral vessels. (Fig. 6.) There were immediate bounding posterior tibial and dorsalis pedis pulsations which have continued. The patient has had complete relief of symptoms on the left. He is to return at a later date for shunting of the obliterated right superficial femoral artery.

CASE IV. W. E. G., a forty-six year old white man, was readmitted to the Veterans Administration Center, Jackson, Mississippi, on July 19, 1956, with diagnoses of hypertensive cardiovascular disease with myocardial insufficiency, chronic non-suppurative frontal sinusitis and arteriosclerosis obliterans of the left external iliac and femoral arteries. The patient had had severe intermittent claudication involving the left lower extremity for two years, which had progressed to such an extent that he was unable to walk more than one block without resting. He also complained of severe night cramps in the left calf. On previous hospitalization a left lumbar sympathetic ganglionectomy had been performed without relief of symptoms. Physical examination revealed an obese, middle-aged white man in no acute distress. There was perforation of the nasal septum. Blood pressure was 140/80. There was absence of dorsalis pedis, posterior tibial, popliteal and femoral pulsations on the left. Pulsations were present on the right and of good quality. The left lower extremity was cooler than the right. There was also paleness on elevation and rubor on dependency on the

left, which was not present on the right. A hemogram and urinalysis were within normal limits. Serology revealed a doubtful VDRL; quantitative VDRL, titer too low for reading; complement fixation was negative. Total cholesterol was 280 mg. per cent; cholesterol esters, 69 per cent. Prothrombin times ranged between 15 and 18 seconds on four occasions. X-ray of the chest was normal. Electrocardiogram revealed a borderline depression of ST_{1-2} and V_{4-5-6}, which might have been due to digitalis or to subendocardial ischemia. Electrocardiogram on October 9th revealed the double Master's test to be positive. An aortogram revealed occlusion of the left external iliac just above the inguinal ligament. (Fig. 7.) Consequently, exploration was done on September 7th, which revealed complete obstruction of the external iliac 5 cm. above the inguinal ligament on the left. The common femoral and superficial femoral arteries were obliterated down to the popliteal. A homologous arteriograft was placed from the external iliac to the popliteal, using the end-to-side technic. (Figs. 8 and 9.) An arteriogram taken at the operating table showed complete patency of the graft with good filling of the distal vessels. The patient immediately had excellent bounding pulsations. He has been completely asymptomatic since surgery.

FIG. 7. Case IV. Preoperative aortogram showing complete obstruction of left external iliac artery.

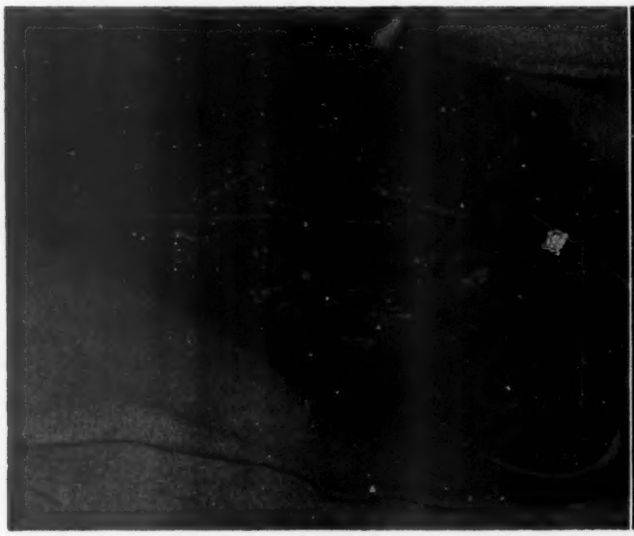

FIG. 8.

FIG. 9.

FIG. 8. Case IV. There was complete obstruction of the distal end of the left external iliac and the common and superficial femoral arteries, requiring a long shunt graft. This shows the details of the end-to-side anastomosis of the homograft to the popliteal artery.

FIG. 9. Case IV. This shows funnel effect of the end-to-side anastomosis between the homograft and the left external iliac above the inguinal ligament.

FIG. 10. Case v. Preoperative aortogram showing complete obliteration of the left common iliac artery and what appears to be incomplete obstruction of the right common iliac. At operation distal end of aorta and both common iliacs were found to be completely obliterated.

Comment. The preceding two cases illustrate the advantage of end-to-side technic in the peripheral vessels, in that a large funnel-shaped anastomotic lumen can be obtained with a consequent freer flow of blood under a higher pressure. Also, a more advantageous site for a proximal anastomosis can be utilized without compromising essential collateral circulation. Destruction of this important circulation could lead to loss of the extremity subsequent to thrombosis of an end-to-end graft.

CASE v. W. L. C., a fifty-nine year old white man, an architect, was admitted to the Medical Service of the Veterans Administration Center, Jackson, Mississippi, on November 26, 1956. He complained of intermittent claudication of the lower extremities of four years' duration, increasing in severity until at the time of admission he was able to walk only a half block before resting. He also had severe intermittent cramps with numbness in both lower extremities. Initially the pain appeared in the lower part of the leg and gradually ascended to involve the entire extremity and up into the back. There had been complete loss of sexual potency for a period of two years. Examination revealed a thin, well developed, middle aged white man. There was a mild increase in normal dorsal kyphosis. A grade III blowing systolic murmur was heard at the aortic area, which radiated up into the right neck vessels. The femoral, dorsalis pedis, posterior tibial and popliteal pulsations were not palpable bilaterally. A soft, blowing, grade II systolic murmur was heard most loudly over the lower edge of the umbilicus. It was also heard in the back over the fourth lumbar vertebra. Examination of the occular fundi revealed moderate narrowing of the arteries and rather marked choroidal sclerosis. Rectal examination revealed 2 plus prostatic hypertrophy. Serology, urinalysis, white blood cell count, differential, hemogram and blood urea nitrogen were normal. X-rays of the chest showed slight emphysema. Cardiovascular size and configuration were normal. Healing rib fractures were reported on the left side involving the posterior segments of the third, fourth and fifth ribs. Abdominal x-ray on November 28th revealed extensive enlarged calcific plaques throughout the abdominal aorta and its pelvic branches. An aortogram taken on November 29th revealed complete occlusion of the terminal aorta, with retrograde filling of the external iliacs which had irregularly narrowed lumens. (Fig. 10.) A diagnosis of Leriche's syndrome was made, and on December 12th an aortic bifurcation homograft bypass from the abdominal aorta to both external iliacs was accomplished using the end-to-side technic. (Fig. 11.) An associated bilateral lumbar sympathectomy was also performed. Immediately after the operation peripheral pulses were found to be of excellent quality and have continued to be so. Repeat aortogram two months postoperatively revealed patency of the aortic bifurcation graft. (Fig. 12.) The patient is now walking long distances without symptoms.

Comment. Utilizing the technic of end-to-side anastomosis of the bifurcation graft to

FIG. 11. Case v. Bifurcation graft in place. End-to-side anastomosis to aorta and external iliacs bilaterally. Right external iliac anastomosis is not shown. End-to-side aortic anastomosis is directly beneath large retractor.

the host aorta proximally and to the external iliacs distally, as in this case, presents certain definite advantages. First, a larger anastomotic lumen can be fashioned without encroaching upon the normal distensibility of the host aorta posteriorly. Second, immediately proximal to the level of complete obstruction of the distal aorta there is usually a large thick posterior atheromatous plaque which must be thromboendarterectomized before a satisfactory aortic wall for end-to-end anastomosis can be obtained. However, the anterior wall is usually soft and pliable and can be utilized with ease in the performance of an end-to-side implantation. Third, collateral circulation is not compromised and even the inferior mesenteric circulation may be saved. This has been shown by Edwards and LeMay [2] frequently to constitute the origin of an extremely important collateral circulation to the lower extremities [3]. Of course, smaller vessels such as the spermatic and ovarian are likewise preserved. Fourth, technically the performance of the end-to-side anastomosis is more easily accomplished than an end-to-end procedure. Fifth, by utilizing the bypass graft the patient's lower extremities are not jeopardized in case of thrombosis of the graft as they necessarily are with a replacement procedure because of destruction of collateral circulation. Sixth, the inferior vena cava and common iliac veins are not disturbed, thereby preventing thrombosis which occasionally follows resection of the terminal aorta and iliacs with replacement technics.

SUMMARY

Analysis of the short term results following end-to-side anastomosis of five arterial homografts is presented. Our immediate results indicate a high percentage of patency with excellent blood flow distally, as demonstrated by bounding peripheral pulses and postoperative arteriograms. Symptomatology of intermittent claudication, rest pain, etc., is either markedly reduced or completely eliminated. As demonstrated by one of our cases, even though the extremity may not be completely restored to normal function if gangrene is present, the level of amputation may be markedly lowered so that a digital removal can be effected instead of an above-the-knee amputation. Performance of end-to-side anastomosis preserves the collateral circulation, which is a safety factor if thrombosis of the graft occurs. It permits placement of the proximal anastomosis at a much higher level so that a greater blood flow under higher pressure is assured. By the utilization of a side of the host artery which is

FIG. 12. Case v. Aortogram two months postoperatively showing complete patency of end-to-side aortic bifurcation graft.

soft and pliable and free from atheromatous plaques, better tissue can be used to fashion the anastomosis without performing an endarterectomy. It is recommended that end-to-side anastomosis to the aorta be used for bifurcation grafts for all the foregoing reasons. Of particular importance is the preservation of essential collaterals such as those originating from the inferior mesenteric and hypogastric arteries which are usually sacrificed by replacement technics.

ADDENDUM

Five additional cases of superficial femoral artery obstruction have been treated by femoral popliteal bypass graft without evidence of thrombosis to date.

REFERENCES

1. CRAWFORD, E. S. et al. Treatment of arteriosclerotic occlusive disease of the lower extremities by excision and graft replacement or by-pass. *Surgery*, 38: 981–992, 1955.
2. EDWARDS, E. A. and LEMAY, M. Occlusion patterns and collaterals in arteriosclerosis of the lower aorta and iliac arteries. *Surgery*, 38: 950–963, 1955.
3. LINDSTROM, B. L. Value of collateral circulation from inferior mesenteric artery in obliteration of the lower abdominal aorta. *Acta chir. Scandinav.*, 100: 367, 1950.
4. LINTON, R. R. Some practical considerations in the surgery of blood vessel grafts. *Surgery*, 38: 817–834, 1955.
5. LINTON, R. R. and MENENDEZ, C. V. Arterial homografts: a comparison of results with end-to-end and end-to-side anastomosis. *Ann. Surg.*, 142: 568–585, 1955.
6. MCALLISTER, F. F. Experiences with replacement of segments of diseased femoral and popliteal arteries. *Surgery*, 38: 964–969, 1955.

The Effect upon Free Hydrochloric Acid Production of Heidenhain Pouches with Variation in Size and Position of a Gastrojejunostomy Stoma

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THE stimulus for this experimental study stems primarily from the observations of Dragstedt and co-workers [1,2] that there is no stimulatory effect on Heidenhain pouch secretion following a low antral gastrojejunostomy with a narrow stoma (less than 3 cm. in diameter). Clinical advice for performing a low gastrojejunostomy in patients with peptic ulcer disease has been based on this evidence. However, we have observed in our laboratory [3], utilizing a larger number of animals, that a definite stimulatory response is produced when a wider stoma (4 cm. in diameter) is used.

After a critical analysis of all the factors involved, the only common variant in the experimental preparations of Dragstedt's and our's which might account for the different results was found to be the size of the gastrojejunostomy stoma. Our experiment consists then of a controlled variation of this factor with other elements remaining equal.

The preliminary data of these experiments have been presented [4]. Since a controversial subject is under consideration which has a direct clinical application, we have increased the number of experiments significantly so that experimental error might be diminished.

METHOD

A group of eleven mongrel dogs of both sexes and weighing between 8 to 15 kg. was used. Environmental conditions were carefully controlled as to kennel temperature, time of feeding and time of collection of Heidenhain secretions. A Heidenhain pouch was constructed in each dog and standardized in the routine manner previously reported [3,5,6].

The results are quantitatively expressed in milliequivalents of hydrochloric acid secreted for twenty-four hours and represent an average of thirty-day collections. After adequate Heidenhain pouch standardization, a low antral antecolic isoperistaltic gastrojejunostomy was performed in all dogs. The jejunal anastomosis was made 10 cm. distal to the ligament of Treitz and in the antrum 2 to 3 cm. proximal to the pylorus. In each instance the procedure was the same except for the construction of the stoma which varied in size from 2 to 4 cm. in diameter. Adequate time was allowed for the animal to recover from the operation before Heidenhain pouch secretions were again collected. After thirty consecutive twenty-four-hour Heidenhain pouch collections had been made, the animals were reoperated upon and the size of the stoma changed. All 2 cm. diameter stomas were converted to 4 cm. diameter, and vice versa. The animals were again allowed to recover from the operative procedures before Heidenhain pouch collections were resumed. Collections were made for a period of thirty days in each animal, after which the stoma was changed to its original diameter and another group of collections made. To terminate the experiment, the gastrojejunostomy was taken down and a final period of Heidenhain pouch collections was made with normal bowel continuity restored.

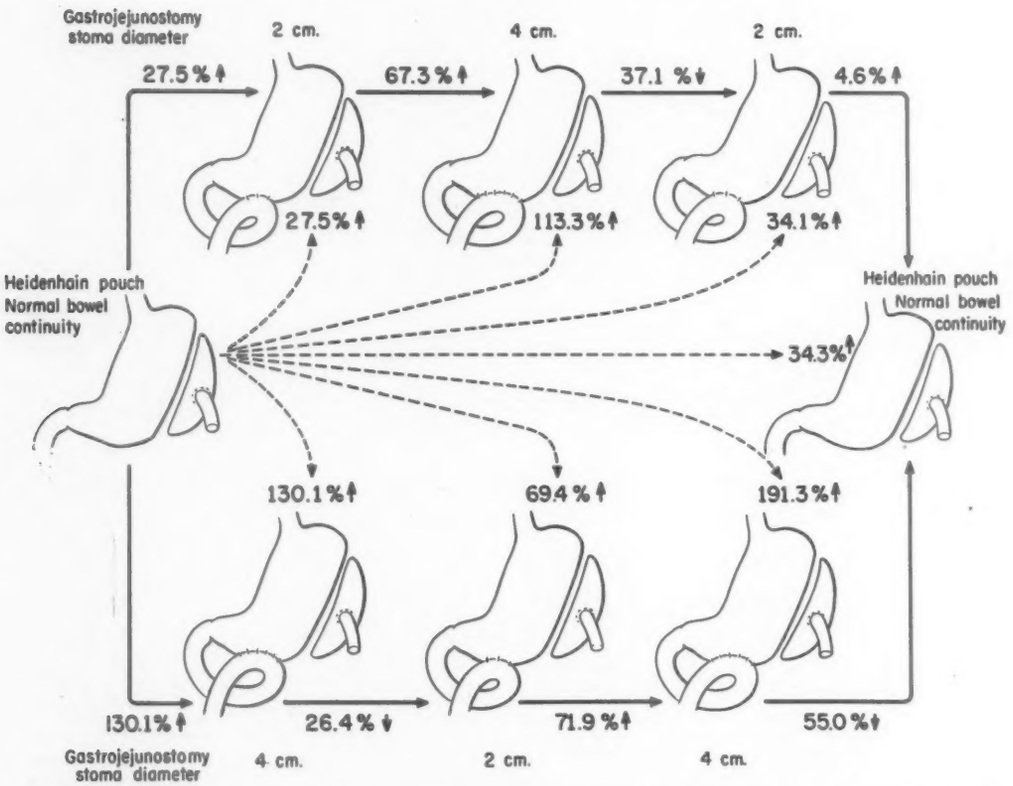


FIG. 1. The sequence of operative procedures with resultant succeeding increases or decreases in free hydrochloric acid secretion from Heidenhain pouches is shown. In the upper portion of the chart the sequence is shown when the first anastomosis was 2 cm. in diameter, while below the sequence is demonstrated when the first anastomosis was 4 cm. in diameter. In all instances the final stage was a complete takedown of the anastomosis. The solid arrows represent average per cent increase (↑) or decrease (↓) of free hydrochloric acid secretion produced by an actual operative procedure. The dotted arrows indicate the percentage increase (↑) of each preparation as compared to the standardized control Heidenhain pouch with normal gastrointestinal continuity. The increases as compared to the control for the 2 cm. stomas were 27.5, 34.1 and 69.4 per cent (average 43.3 per cent). The increases as compared to the control for the 4 cm. stomas were 113.3, 130.1 and 191.3 per cent (average 144.9 per cent). The over-all effect of multiple procedures following takedown of the anastomosis in the eleven dogs was a 34.3 per cent increase.

In each instance stoma sizes were measured *in vivo* as accurately as possible with glass rods 2 and 4 cm. in diameter at the time of construction and at the time of conversion. Additional *in vivo* barium studies were made to determine the relative patency of the stomas and the main direction of flow.

RESULTS

The animals tolerated the multiple operative procedures well, as evidenced by maintenance of body weight, appetite and general well-being.

When compared to the standardized Heidenhain pouch secretions, there was an average increase of 43.3 per cent in the secretions collected during the periods that the animals had a gastrojejunostomy with a 2 cm. stoma. However, when the animals had a 4 cm. diameter gastrojejunostomy stoma, there was a greater increase in secretion of hydrochloric acid by the Heidenhain pouch, averaging 144.9 per cent. When the gastrojejunostomy was taken down and the Heidenhain pouch restandardized, there was a 34.3 per cent increase in secretions of hydrochloric acid over the pre-gastrojejunostomy level. (Figs. 1 and 2.)

Barium studies done in each interval demonstrated the stoma to be patent in every instance. In general, when the animal had the 2 cm. diameter gastrojejunostomy stoma, there was a greater tendency for the barium to flow through the duodenum although some was seen to enter the jejunum directly. When the animal had a 4 cm. diameter gastrojejunostomy stoma, the flow of barium was directly into the jejunal loop with very little entering the duo-

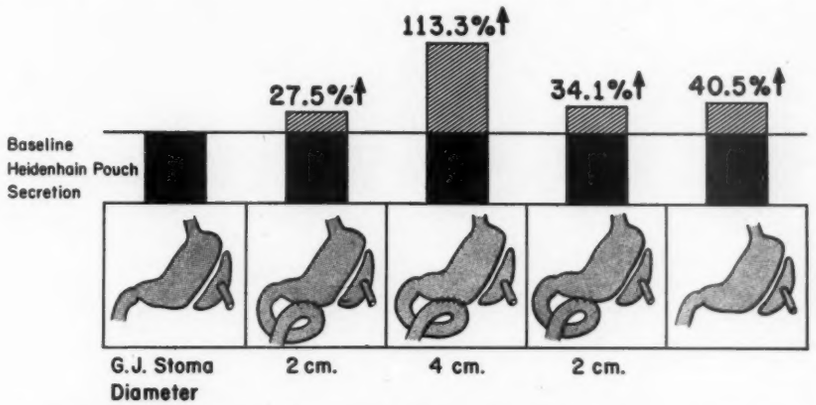


FIG. 2A. Sequence of operative procedures when the first anastomosis was 2 cm. in diameter, and the average per cent increase or decrease in Heidenhain pouch secretion over each preceding preparation. The increase as compared to the control for the 2 cm. stoma was 27.5 per cent, for the 4 cm. stoma 113.3 per cent, again for the 2 cm. stoma 34.1 per cent, and finally the postexperiment base line Heidenhain pouch secretion of 40.5 per cent.

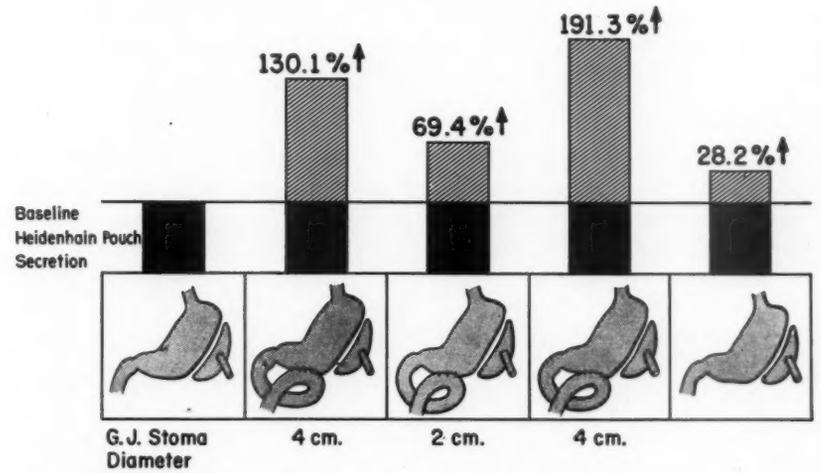


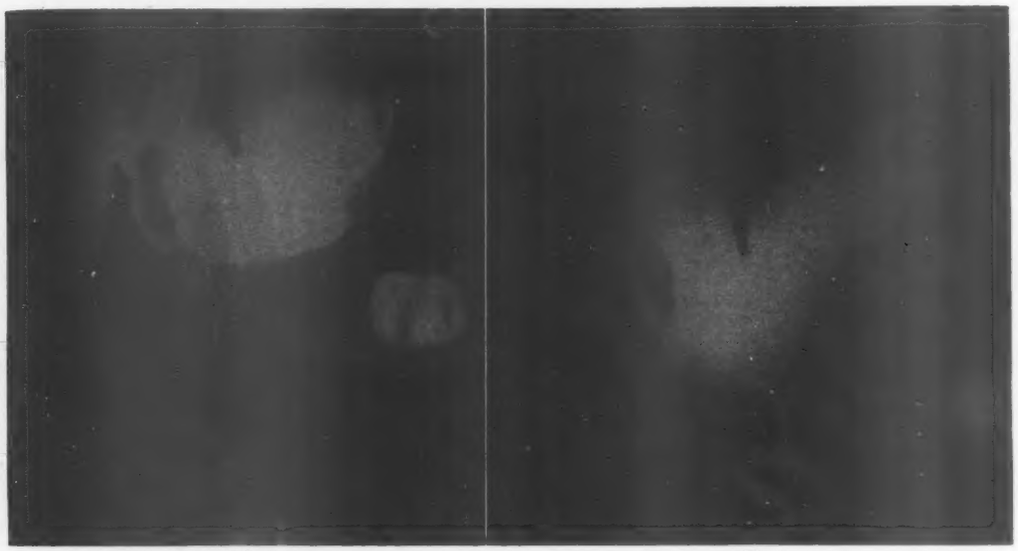
FIG. 2B. Sequence of operative procedures when the first anastomosis was 4 cm. in diameter, and the average per cent increase or decrease in Heidenhain pouch secretion over each preceding preparation. The increase as compared to the control for the 4 cm. stoma was 130.1 per cent, for the 2 cm. stoma, 69.4 per cent, again for the 4 cm. stoma 191.3 per cent, and finally for the postexperiment base line pouch secretion of 28.2 per cent.

denum. (Fig. 3.) Evaluation of intragastric regurgitation or circus movement was not possible.

COMMENTS

Earlier work in our laboratory [3,5,6] showed that there was very little variation in the increased Heidenhain pouch secretion resulting from making the gastrojejunostomy stoma in a high or medium position on the main stomach. This was in agreement with the findings of Dragstedt and his co-workers [1,2]. With a low antral gastrojejunostomy stoma, we found a definite increase in pouch secretions in contrast to Dragstedt's finding of no change. If Dragstedt's hypothesis is correct, one might expect to find a decreased incidence of stomal ulceration with the gastrojejunostomy stoma placed near the pylorus. In 1956 Tanner [7] mentioned that in his clinical experience there has been a definitely higher incidence of stomal ulceration when a gastrojejunostomy stoma is placed low in the stomach near the pylorus.

We believe that the increased stimulation of the Heidenhain pouch is partly a result of circus movement or reflux of alkaline duodenal



3A 3B

FIG. 3. A, barium study of typical preparation with 2 cm. gastrojejunostomy stoma. Most of the barium goes out of the pylorus, only a portion through the stoma. B, barium study of typical preparation with 4 cm. gastrojejunostomy stoma. All the barium goes through the stoma, none through the pylorus. (From: STEVENSON, J. K. et al. *S. Forum*, 7: 386–389, 1957.)

juice into the antrum. From our barium studies it would appear that in order to construct a stoma that will function as an adequate drainage mechanism for the stomach, it would by necessity have to be large enough to allow the undesirable reflux to occur. This reflux probably results in increased hormonal stimulation of hydrochloric acid secretion.

There are many theoretic explanations as to why this increased secretion does occur [*8–14*]. At present, we believe this is the result of four primary factors: (1) increased antral stimulation resulting from reflux of alkaline duodenal content into the antrum of the stomach; (2) a decrease of duodenal inhibition resulting from the detouring of acid gastric content away from the duodenum and into the jejunum; (3) circus movement with continued mechanical stimulation of the antrum by repetitious passage of food over the antrum; (4) increased intestinal phase resulting from larger particles of food passing directly into the jejunum.

It appears, then, that the larger the gastrojejunostomy stoma, the greater the reflux and subsequent antral stimulation up to a maximum point. The smaller the gastrojejunostomy stoma, the smaller the amount of reflux taking place with a concomitant decrease in stimulation to a minimum. For clinical application, this evidence again emphasizes the unsound physiologic basis for simple gastrojejunostomy as used for the treatment of peptic ulcer disease.

SUMMARY

Under the conditions of this experimental study we found that there was only a moderate increase in Heidenhain pouch secretion following a low antral gastrojejunostomy if the stoma was constructed 2 cm. in diameter. If, however, the gastrojejunostomy stoma was constructed 4 cm. in diameter, there was a marked increase. The average increase in secretion of free hydrochloric acid from the Heidenhain pouch when stimulated by a 2 cm. diameter gastrojejunostomy stoma was 43.3 per cent. For a 4 cm. stoma the similar average was 144.9 per cent, or over three times as much. If the 34.3 per cent increase produced by multiple operations alone is considered, this difference is even greater.

REFERENCES

1. ZUBIRAN, J. M., KARK, A. E., MONTALBETTI, A. J., MOREL, C. J. L. and DRAGSTEDT, L. R. Quantitative studies on the effect of gastrojejunostomy on gastric secretion. *Arch. Surg.*, *65*: 239–249, 1952.
2. ZUBIRAN, J. M., KARK, A. E., MONTALBETTI, A. J., MOREL, C. J. L. and DRAGSTEDT, L. R. Quantitative studies on the effect of gastrojejunostomy on gastric secretion. *S. Forum* (1952), pp. 5–11, 1953.

3. KANAR, E. A., SCHMITZ, E. J., NYHUS, L. M., MOORE, H. G., JR., SAUVAGE, L. R., STORER, E. H. and HARKINS, H. N. Effect of high, low and medium gastrojejunostomy to the main stomach on Heidenhain pouch secretion. *Am. J. Physiol.*, 175: 167–169, 1953.
4. STEVENSON, J. K., JESSEPH, J. E., JONES, T. W. and HARKINS, H. N. Secretory response to gastrojejunostomy as affected by position on the stomach and variation in stomal diameter. *S. Forum*, 7: 386–389, 1957.
5. SCHMITZ, E. J., KANAR, E. A., STORER, E. H., SAUVAGE, L. R. and HARKINS, H. N. Heidenhain pouch secretory response as affected by gastrojejunostomy to the main stomach. *Proc. Soc. Exper. Biol. & Med.*, 81: 170–172, 1952.
6. KANAR, E. A., SCHMITZ, E. J., SAUVAGE, L. R., STORER, E. H. and HARKINS, H. N. The secretory response of the stomach to gastroenterostomy as measured by a Heidenhain pouch. *S. Forum* (1952), pp. 12–17, 1953.
7. TANNER, N. Personal communication, London, May 3, 1956.
8. STORER, E. A., OBERHELMAN, A. A., WOODWARD, E. R., SMITH, C. A. and DRAGSTEDT, L. R. Effect of the Exalto-Mann-Williamson procedure on gastric secretion. *Arch. Surg.*, 64: 192–199, 1952.
9. KESAVALU, A. and MANN, F. C. The influence of duodenal contents on intragastric acidity. *Surgery*, 14: 578–587, 1943.
10. WOODWARD, E. R., STEVENS, G. A. and ROBERTSON, C. The role of the antrum in surgery for duodenal ulcer. *Arch. Surg.*, 72: 1003–1008, 1956.
11. DAY, J. J. and WEBSTER, D. R. The autoregulation of the gastric secretion. *Am. J. Digest. Dis.*, 2: 527–531, 1953.
12. GRIFFITHS, W. J. The duodenum and the automatic control of gastric acidity. *J. Physiol.*, 87: 34–40, 1936.
13. PINCUS, I. J., THOMAS, J. E. and REHFUSS, M. E. A study of gastric secretion as influenced by changes in duodenal acidity. *Proc. Soc. Exper. Biol. & Med.*, 51: 367–368, 1942.
14. BRACKNEY, E. L., THAL, A. P. and WANGENSTEEN, O. H. Role of duodenum in control of gastric secretion. *Proc. Soc. Exper. Biol. & Med.*, 88: 302–306, 1955.

Pseudomembranous Enterocolitis

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PSEUDOMEMBRANOUS enterocolitis is not a new disease but has received much attention recently because of its apparent relationship to antibiotic therapy and because of an apparent increase in incidence.

This process has been known by a variety of names including, among others, diphtheritic colitis or enterocolitis, acute necrotizing hemorrhagic enterocolitis and staphylococcal enterocolitis. The name pseudomembranous enterocolitis has received wide acceptance and seems to fit the pathologic picture suitably.

Apparently the first published reference to the process was by Finney (1893) [*1*]. Penner and Bernheim in 1939 [*2*] collected forty cases of enterocolitis from autopsy records of postoperative patients. Dixon and Weismann (1948) [*3*] reviewed twenty-three cases of acute pseudomembranous enterocolitis occurring after operations on the intestinal tract and Pettet and associates (1954) [*4*] reviewed 107 autopsied cases collected over a twenty-seven year period. These, too, were all postoperative patients. In the majority of the cases in the latter series surgery had involved the gastrointestinal tract. Pettet and her colleagues felt there was no conclusive evidence of an increased incidence of pseudomembranous enterocolitis at the Mayo Clinic since the introduction of antibiotics. Other authors, however, have maintained that a sharp increase in the incidence of the disease has occurred in the past ten to fifteen years [*5,6*]. It has been suggested, furthermore, that this process associated with antibiotics is a different entity from what morphologically and clinically is the same picture but arising in the absence of antibiotic therapy [*7–10*]. In recent years many other series and case reports [*11–25*] have added considerably to the knowledge of pseudomembranous enterocolitis but much yet remains to be learned particularly as to its etiology and pathogenesis.

ETIOLOGY

On an etiologic basis it would appear that cases of pseudomembranous enterocolitis may be divided into two principal groups: idiopathic, those for which no etiologic agent is apparent; and "antibiotic," those which follow and seem related to the administration of some antibiotic agent. Admittedly this may be an artificial partition and certainly has been made only for convenience of discussion.

Penner and Bernheim [*2*] suggested the common denominator of shock as a causative factor since it appeared in all of their cases. However, it would appear from many clinical studies including the present one that vascular collapse occurred after onset and as a result of the disease rather than as a cause of it.

In those cases associated with antibiotic therapy various mechanisms have been incriminated. Most theories involve the alteration of the normal intestinal flora by suppression of most of the inhabitants including the gram-negative bacilli thereby allowing uninhibited growth of an antibiotic resistant strain of Staphylococcus aureus. The latter may produce the disease process by invasion of the bowel wall and blood stream as indicated by positive blood stream cultures obtained in some patients [*12,15,20*]. On the other hand, the pathologic picture may be produced by production of an enterotoxin [*9,19,20,26*]. The clinical picture is very similar to that seen in staphylococcal food poisoning. However, because of the continuing production of the toxin within the bowel the process is not a brief, violent, self-limited attack (as it is after a single ingestion of contaminated food) but a continuing one. This thesis is supported by Surgalla and Dack [*26*] who found that an enterotoxin was produced by thirty of thirty-three strains of

S. aureus isolated from patients in whom enteritis developed after antibiotic therapy. It has also been suggested that pseudomembranous enterocolitis may be a result of a local tissue sensitivity reaction similar to the Shwartzman phenomenon.

There is evidence that specific strains of S. aureus may be responsible for this disease [*26,27*]. A high percentage of such organisms are hemolytic, coagulase positive and apparently of the same phage type. Furthermore, a high percentage of the strains of S. aureus showing resistance to many or all types of antibiotics exhibit these characteristics. Such strains are found in higher percentages of throat cultures among hospital personnel than in the population at large. Furthermore, these strains of S. aureus appear in patients in increasing incidence the longer they remain in the hospital whether or not they are receiving antibiotic therapy [*27*].

Another possible mechanism involved is sensitivity of the patient to the antibiotic agent [*28*]. It would seem that this would best explain some of the reported cases in which the fully developed picture of pseudomembranous enterocolitis follows administration of an antibiotic by only a few hours. In such cases, it would hardly seem possible that sufficient time had elapsed for suppression of normal flora with overgrowth of another organism.

Pettet [*4*] has suggested that obstruction of the gastrointestinal tract may be of etiologic importance in the development of pseudomembranous enterocolitis, presumably by altering the permeability of the bowel wall thus allowing free invasion by the pathogenic organism. In the present series there was no case which exhibited intestinal obstruction, however one patient did have a partially obstructing duodenal ulcer.

PATHOLOGY

The pathologic picture of pseudomembranous enterocolitis is non-specific. Except for the finding in some cases of clumps of gram-positive cocci on and within the bowel wall, the appearance grossly and microscopically simulates that seen in the enteritis accompanying heavy metal poisoning, uremia, septicemia, bacillary dysentery, paratyphoid colitis and other similar toxic states. The process may involve any part of the gastrointestinal tract from esophagus to anus but is most common in the lower ileum and colon. It may be limited to small multiple areas or spread to involve the entire gastrointestinal tract in continuity. The bowel is dilated and contains much fluid. The serosa is somewhat reddened and the mucosa shows areas covered with a fairly well developed yellowish to brownish pseudomembrane.

Microscopically, there is edema and necrosis of the mucosa with round cell infiltration which may extend into the submucosa. The pseudomembrane is composed of necrotic mucosal debris, inflammatory cells and, sometimes, clumps of bacteria. In occasional cases the involvement may extend through all layers of the bowel wall and full thickness necrosis and perforation may result. This infarction occurs in the absence of vascular thrombosis.

CLINICAL COURSE

The clinical course of pseudomembranous enterocolitis in its typical fully developed state is a most violent and dramatic one. The outstanding features are profuse watery diarrhea, fever and shock. Diarrhea is not always present, being reported in 30 to 100 per cent of various series [*3–5,12,13*]. It was noted in all but two of the present series and in nine of fourteen cases was the first symptom noted. (Table 1.) It is usually an uncontrollable, often constant, outpouring of watery, brownish stool with relatively little odor. It does not often contain gross blood which seems somewhat surprising in view of the nature of the process. Bloody stools were observed in two of the present series. Fever is almost uniformly present and often rapidly rises to levels of 105° to 107°F. Only one patient of the present series had no significant elevation of the temperature. Peripheral vascular collapse supervenes early in the course and is due to the loss of large quantities of water and electrolytes into and from the bowel as well as to capillary dilation which may be present and presumably is due to intoxication. The patient may be in profound vascular collapse with undetectable pulse and blood pressure and yet be warm to the tips of the digits. In the present series four patients had peripheral vascular collapse as the first symptom, and it subsequently occurred in thirteen of fourteen patients whose blood pressure was recorded. One infant, twenty-two months of age, had no blood pressure recordings.

TABLE I

CLINICAL DATA ON FIFTEEN PATIENTS WITH PSEUDOMEMBRANOUS ENTEROCOLITIS

Name	Sex, Age	Diagnosis and Operation	Antibiotics before Onset	First Symptom	Peripheral Vascular Collapse	Diarrhea	Distention	Vomiting	Fever	Stool Smear	Result
R. F.	M, 47	Peptic ulcer: postgastroenterostomy, vagotomy	Penicillin	Diarrhea	+	+	−	−	+	+	Lived
E. S.	M, 74	Peptic ulcer: subtotal gastrectomy	Streptomycin	Shock	+	+	+	−	+	+	Lived
E. J.	F, 18	Appendicitis:* appendectomy	None	Shock	+	+	+	−	+	−	Lived
L. R.	M, 2	Pneumonitis and asthma	Terramycin	Diarrhea and vomiting	Not known	+	?	+	+	+	Lived
F. S.	M, 65	Diabetic gangrene: transmetatarsal amputation	Penicillin, chloromycetin	Diarrhea	+	+	?	−	+	+	Lived
G. F.	M, 60	Fractured hip: hip nailing	Penicillin	Diarrhea	+	+	−	−	+	−	Died
H. W.	M, 53	Peptic ulcer: subtotal gastrectomy	Penicillin	Diarrhea	+	+	+	+	+	+ (At death)	Died
P. N.	M, 67	Pneumonia	Terramycin	Diarrhea and vomiting	+	+	+	+	+	+	Died
J. L.	M, 71	Carcinoma of esophagus: esophagectomy	Penicillin	Diarrhea	+	+	+	−	+	+ (At death)	Died
R. F.	M, 52	Gastrointestinal bleeding: subtotal gastrectomy	Penicillin	Shock	+	−	−	−	−	Not done	Died
S. W.	F, 66	Congestive heart failure; hepatoma	Chloromycetin	Diarrhea	−	+	?	−	+	+	Died
C. W.	M, 68	Carcinoma of rectum; diverticulitis: left hemicolectomy*	None	Shock	+	+	+	−	+	Not done	Died
C. S.	F, 77	Arteriosclerotic gangrene: exploratory laparotomy; supracondylar amputation	Terramycin, penicillin	Diarrhea	+	+	+	+	+	Not done	Died
W. M.	M, 69	Prostatic hypertrophy with hydronephrosis; bleeding peptic ulcer: subtotal gastrectomy	Penicillin, aureomycin	Diarrhea	+	+	+	+	+	Not done	Died
O. Z.	M, 60	Chronic duodenal ulcer: subtotal gastrectomy	Penicillin	Fever	+	−	+	−	+	Not done	Died

* Operation after onset of symptoms.

Moderate to severe distention is usually present and nausea and emesis may accompany the picture. However, several patients were able to take fluids and medication by mouth throughout most of the course of their disease.

Pain is not a prominent feature of the clinical picture; and in those that have it, it ranges from mild or moderate discomfort to severe cramps.

If treatment is unsuccessful, the patient usually dies within twenty-four to forty-eight hours of onset of shock and with associated renal shutdown.

DIAGNOSIS

Pseudomembranous enterocolitis will only be recognized clinically if a high degree of suspicion is maintained. In any patient under antibiotic treatment the development of diarrhea and fever should suggest the possibility of enterocolitis. If other elements of the clinical picture are present the diagnosis should be

made and treatment started immediately. A smear of stool showing a relative increase in the numbers of gram-positive cocci in the flora helps to confirm the diagnosis.

In the present series, smears in six of ten cases which were made during life showed large numbers of gram-positive cocci with decrease in gram-negative organisms. Cultures should be started at once to categorize the organism and determine its antibiotic sensitivity. Such cultures should not be made on those media used for routine stool studies but should be innoculated on blood agar to which 0.25 per cent phenylethyl alcohol has been added. Treatment should not await the results of cultural studies as a delay of six to twenty-four hours may prove to be fatal in most cases.

Sigmoidoscopy, if it can be carried out, may disclose the typical areas of membranous involvement and smears taken of the mucosa may reveal organisms not seen on smears of the stool. Conditions to be differentiated include peritonitis, pancreatitis and small bowel obstruction. All of these conditions in their typical form are usually readily diagnosed but in the postoperative patient may exhibit bizarre and atypical pictures. In the absence of diarrhea the differentiation between peritonitis and pseudomembranous enterocolitis may be virtually impossible but smears and cultures of the bowel wall may be helpful and treatment based on correcting physiologic imbalances and change in antibiotic therapy may be satisfactory for both. The rather typical pain pattern, serum amylase, and recovery of characteristic peritoneal fluid by paracentesis will aid in the diagnosis of pancreatitis. The typical crampy pain and x-ray pattern usually assures the diagnosis of small bowel obstruction, but when the block is incomplete and accompanied by diarrhea the differentiation may be difficult.

TREATMENT

Therapy is designed to correct the physiologic disturbances and remove the cause of the disease, if possible. When diarrhea begins intravenous fluids and electrolytes, especially sodium chloride, must be given in large quantities to maintain blood volume at a level sufficient to support the blood pressure and provide a good urine output. Blood levels of sodium, potassium, chloride and carbon dioxide should be determined at frequent intervals to help in planning the amounts of the various electrolytes to be given. However, treatment should not wait on fine laboratory calculations of the patient's exact needs but should proceed on the best clinical estimates based on such information as the patient's blood pressure, volume and specific gravity of urine output, making use of other more complicated laboratory aids when and as they become available.

Estimating the quantity of liquid stool may help in adjusting fluid administration but may be grossly misleading since large quantities of fluid may be retained within the lumen of the bowel.

The use of norepinephrine or some other vasopressor substance may be required to help support the blood pressure by counteracting the marked vasodilation which often is present.

Any antibiotic in use when pseudomembranous enterocolitis develops should be discontinued and some other given in its place. The drug of choice may vary in different centers. In this hospital erythromycin has had very little routine usage and remains highly effective against most S. aureus strains. However, it is known that strains of S. aureus readily develop resistance to this drug [*29,30*]. This should be borne in mind when therapy for this disease is planned. Chloromycetin® has been slower to lose its effectiveness against S. aureus [*31*] than the drugs of the tetracycline group and may be of use. Oral neomycin and bacitracin may also be effective.

The use of ACTH and adrenocortical hormones has been recommended [*9,19,25*], but certainly must be used with caution if the underlying cause is believed to be infectious. We have used ACTH in one case without noticeable benefit. We have used whole adrenal extract and believe that this is a preferable preparation if steroid therapy is felt to be indicated.

CASE REPORTS

E. J., an eighteen year old Negro girl, was admitted to the hospital March 30, 1955, with a one-month history of intermittent abdominal pain in the left lower quadrant. The pain became more severe three days prior to admission and was associated with diarrhea and emesis. She appeared acutely ill and had a temperature of 99.6°F. There was mild abdominal distention, tenderness in the left lower quadrant of the abdomen, and hypoactive peristalsis. Cul-de-sac aspiration produced a small amount of turbid fluid. Two hours later

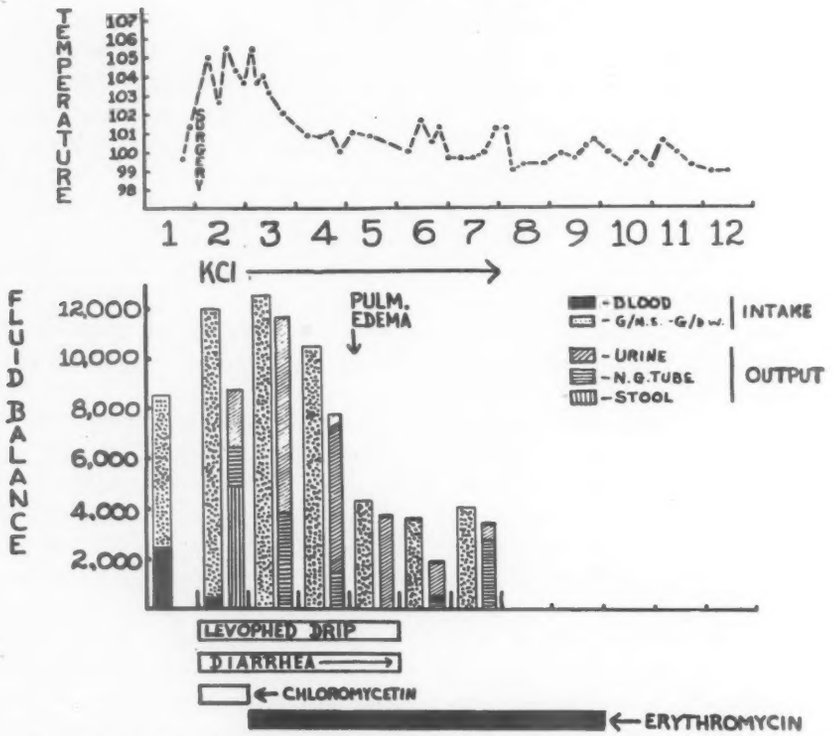

FIG. 1. Case of E. J. Clinical summary of patient with acute pseudomembranous enterocolitis.

she was seen by the surgical consultant. Findings at this time were: temperature, 101.6°F.; pulse, 160; white blood cell count, 32,000 per cu. mm.; generalized lower abdominal tenderness, rebound tenderness, and spasm. It was thought that there was a mass in the left adnexal region. Shortly after this examination the blood pressure fell to 60/40 mm. Hg. Whole blood transfusion was started and the patient was operated upon immediately with a diagnosis of ruptured ectopic pregnancy. At operation, the patient was noted to have a mild salpingitis and diffuse reddening and dilation of the small bowel. The patient received 2,000 cc. of blood during surgery. She was started on chloromycetin and penicillin, and shortly after surgery the patient's temperature rose to 105°F. She began to have profuse diarrhea and developed profound shock.

The course of therapy is illustrated in Figure 1. On the morning of the second day a smear of stool revealed gram-positive cocci and erythromycin was started.

On the third day the patient had findings of pulmonary edema which was treated with rapid digitalization. The diarrhea gradually subsided, and the patient was discharged on April 25, 1955.

This patient is believed to have had enterocolitis associated with a mild salpingitis without antibiotic therapy. Subsequent prompt treatment saved her life, but overtreatment nearly resulted in a fatality. She received 3,000 cc. of whole blood and 43,000 cc. of other intravenous fluids in the first eighty hours. In retrospect, it is obvious that intravenous fluid therapy should have been reduced after the second day as the patient had already begun to take fluids orally and more attention could have been paid to the amount of urine.

R. F., a forty-seven year old white man, was admitted to the hospital October 31, 1954, with a partially obstructing duodenal ulcer. Because of a respiratory infection he was treated initially with procaine penicillin. He was operated upon November 5, 1954, at which time a vagotomy and posterior gastrojejunostomy were performed. Postoperatively streptomycin was given in addition to penicillin. On the evening of the first postoperative day the patient had two watery stools. The following morning he had more watery diarrhea which was an almost continuous flow. His pulse rose to 130 and his blood pressure fell to 80/75 mm. Hg. Administration of penicillin and streptomycin was

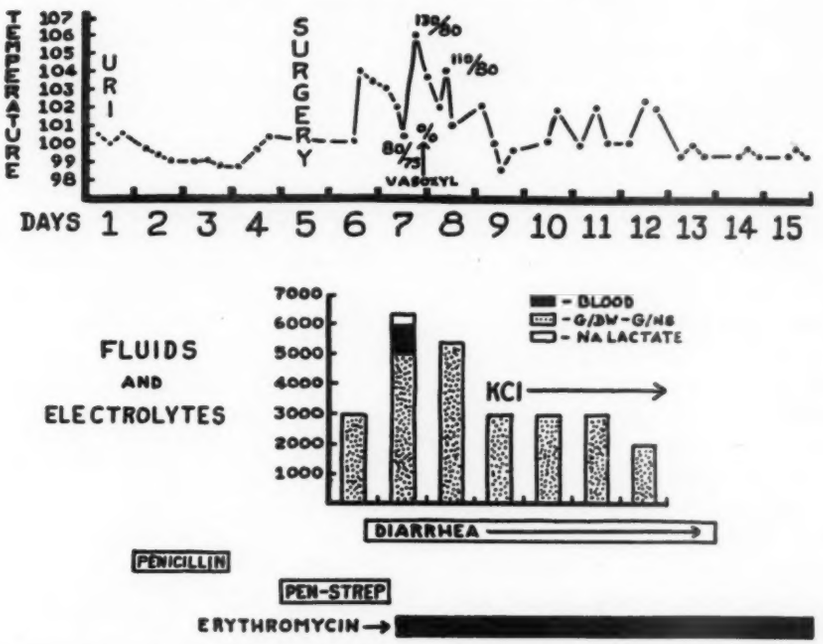

FIG. 2. Case of R. F. Clinical summary of patient with acute pseudomembranous enterocolitis.

stopped and erythromycin (200 mg. every 4 hours) started orally. Smear of the stool showed clumps of gram-positive cocci. He was treated with norepinephrine and copious quantities of intravenous fluids as shown in Figure 2. The temperature reached a peak of 106°F. on the evening of the second day. The following day the patient was improved and his blood pressure stabilized. The diarrhea gradually subsided during the next five days during which time intravenous fluids were given to supplement oral intake. He was discharged on November 19, 1954.

COMMENTS

It is apparent that pseudomembranous enterocolitis, while fortunately not common, is nevertheless a fulminating, frequently fatal process. Only prompt recognition and heroic treatment will lower the high mortality associated with this disease. Shock develops early and treatment must be directed at correcting the fluid and electrolyte imbalances which are largely responsible for the vascular collapse, before irreparable damage is done. The other shock producing factor active is capillary dilation and its effect may be overcome by the use of vasopressors.

Early recognition requires an awareness of the condition coupled with an alert attitude to detect the earliest symptoms of pseudomembranous enterocolitis. Most often in this series the onset was indicated by diarrhea (in ten of fifteen cases) and diarrhea developed in a severe form in all but two cases. This is different from the experience of some who have reported its presence in as few as 30 per cent of cases.

In any patient under treatment with antibiotics the development of diarrhea should put the physician on his guard and if it should become severe or is accompanied by any of the other common signs or symptoms of pseudomembranous enterocolitis that diagnosis should be entertained. Cultures of the stool should be made for guidance in subsequent therapy but treatment should not be delayed until cultures are reported from the laboratory. A simple gram stain of the stool may be helpful in revealing overgrowth of gram-positive cocci and if positive specific treatment should be instituted at once.

Certain prophylactic measures may be taken to reduce the incidence of pseudomembranous enterocolitis: (1) Wholesale prophylactic use of antibiotics in clean surgical operations should be avoided. (2) Use of indicated antibiotics should not be prolonged unduly. (3) Frequent checks of sensitivity of organism to antibiotics should be made as guides to intelligent therapy.

(4) Use of antibiotics in preparation of the intestinal tract should be short and intensive if used at all, and a smear and culture of bowel flora at the time of surgery may help to anticipate difficulty. It has been suggested that a twenty-four-hour course of oral neomycin and bacitracin is the most feasible bowel "sterilization" at present [32]. Perhaps we should follow the advice of McKittrick [33] to discard "the surgeon's bib" and use no routine antibiotic sterilization in preoperative bowel preparation. (5) Care should be taken to avoid cross contamination from known cases of pseudomembranous enterocolitis to other hospital patients.

While pseudomembranous enterocolitis may develop in association with many other conditions it most commonly is seen following operations upon the gastrointestinal tract. Seven of the present cases fall in this group, while the others represent a variety of associated diseases. Although the exact nature of the role antibiotics play in the etiology of this disease is questioned, they are frequently incriminated and all the common antibiotics have been reported in this role.

SUMMARY

A series of fifteen cases of pseudomembranous enterocolitis is presented. Twelve of these cases were recognized clinically with five survivals. The course and management is discussed and suggestions made for prophylaxis against the disease.

REFERENCES

1. Finney, J. M. T. Gastroenterostomy for cicatrizing ulcer of the pylorus. *Bull. Johns Hopkins Hosp.*, 4: 53, 1893.
2. Penner, A. and Bernheim, A. I. Acute postoperative enterocolitis. A study on the pathologic nature of shock. *Arch. Path.*, 27: 966, 1939.
3. Dixon, C. F. and Weismann, R. E. Acute pseudomembranous enteritis or enterocolitis: a complication following intestinal surgery. *S. Clin. North America*, 28: 999, 1948.
4. Pettet, J. D., Bagganstoss, A. H., Dearing, W. H. and Judd, E. S., Jr. Postoperative pseudomembranous enterocolitis. *Surg., Gynec. & Obst.*, 98: 546, 1954.
5. Reiner, L., Schlesinger, M. J. and Miller, G. M. Pseudomembranous colitis following aureomycin and chloramphenicol. *Arch. Path.*, 54: 39, 1952.
6. Weismann, R. E. and Twitchell, E. B. Acute pseudomembranous enterocolitis in the postoperative patient. *Ann. Surg.*, 144: 32, 1956.
7. Smith, D. T. The disturbance of the normal bacterial ecology by the administration of antibiotics with the development of new clinical syndromes. *Ann. Int. Med.*, 37: 1135, 1952.
8. Editorial. Antibiotics, staphylococcal enteritis and pseudomembranous enterocolitis. *New England J. Med.*, 249: 37, 1953.
9. Van Prohoska, J., Long, E, T. and Nelson, T. S. Pseudomembranous enterocolitis, its etiology and the mechanism of the disease process. *Arch. Surg.*, 72: 977, 1956.
10. Speare, G. Staphylococcus pseudomembranous enterocolitis, a complication of antibiotic therapy. *Am. J. Surg.*, 88: 523, 1954.
11. Kramer, I. Fatal staphylococcal enteritis developing during streptomycin therapy by mouth. *Lancet*, 255: 646, 1948.
12. Kleckner, M. S., Jr., Bargen, J. A. and Baggenstoss, A. H. Pseudomembranous enterocolitis: clinicopathologic study of fourteen cases in which disease was not preceded by operation. *Gastroenterology*, 21: 212, 1952.
13. Hilsabeck, J. R. and Dixon, C. F. Treatment of acute postoperative pseudomembranous enterocolitis. *Am. J. Surg.*, 84: 114, 1952.
14. Dearing, W. H. and Heilman, F. R. Micrococcus enteritis as a complication of antibiotic therapy: its response to erythromycin. *Proc. Staff. Meet., Mayo Clin.*, 28: 121, 1953.
15. Kleckner, M. S., Jr., Bargen, J. A. and Baggenstoss, A. H. Acute pseudomembranous enterocolitis. *Proc. Staff. Meet., Mayo Clin.*, 28: 313, 1953.
16. Brown, W. J., Winston, R. and Sommers, S. C. Membranous staphylococcal enteritis after antibiotic therapy: report of two cases. *Am. J. Digest. Dis.*, 20: 73, 1953.
17. Wakefield, R. D. and Sommers, S. C. Fatal membranous staphylococcal enteritis in surgical patients. *Ann. Surg.*, 138: 249, 1953.
18. Terplan, K., Paine, J. R., Sheffer, J., Egan, R. and Lansky, H. Fulminating gastroenterocolitis caused by staphylococci: its apparent connection with antibiotic medication. *Gastroenterology*, 24: 476, 1953.
19. Fairlie, C. W. and Kendall, R. E. Fatal staphylococcal enteritis following penicillin and streptomycin therapy. *J. A. M. A.*, 153: 90, 1953.
20. Van Probaska, J., Jr., Govaskis, M. C. and Taubenhaus, M. Postoperative pseudomembranous enterocolitis, successful treatment with corticotropin (ACTH). *J. A. M. A.*, 154: 320, 1954.
21. Childs, S. B. and Beatty, E. C., Jr. Fatal enteritis: relation to antibiotic therapy. *Arch. Surg.*, 68: 486, 1954.
22. Nyhus, R. E. and Burke, E. C. Pseudomembranous enterocolitis: medical treatment with recovery. *Proc. Staff. Meet., Mayo Clin.*, 29: 513, 1954.
23. Jonassen, O. T., Fierst, S. M. and Cincotti, J. J. Management of pseudomembranous enterocolitis with shock. *New England J. Med.*, 252: 792, 1955.
24. Austrian, R. Staphylococcal enteritis as a complication of antibiotic therapy. *New York State J. Med.*, 55: 2475, 1955.
25. Johnston, J. H., Jr., Bronnan, C. D. and Heard, K. M. Pseudomembranous enterocolitis. *Surgery*, 39: 975, 1956.
26. Surgalla, M. J. and Dack, G. M. Enterotoxin

produced by micrococci from cases of enteritis after antibiotic therapy. *J. A. M. A.*, 158: 149, 1955.

27. KNIGHT, V. and HOLZER, A. R. Studies on staphylococci from hospital patients. I. Predominance of strains of group III phage patterns which are resistant to multiple antibiotics. *J. Clin. Investigation*, 33: 1190, 1954.
28. DASCOMB, H. E. Personal communication.
29. FINLAND, M. Emergence of antibiotic resistant bacteria. *New England J. Med.*, 253: 909, 1951.
30. WISE, R. I., VOIGT, A. E., COLLINS, M. V. and CRANNY, C. L. Origin of erythromycin resistant strains of micrococcus pyogenes in infections *Arch. Int. Med.*, 95: 419, 1955.
31. ALTEMEIER, W. A., CULBERTSON, W. R., SHERMAN, R., COLE, W., ELSTER, W. and FULTZ, C. T. Critical re-evaluation of antibiotic therapy in surgery. *J. A. M. A.*, 157: 305, 1955.
32. FOG, C. V. M. Studies on reduction of intestinal flora: preoperative treatment of patients with lesions of colon or rectum. *Arch. Surg.*, 69: 858, 1954.
33. MCKITTRICK, L. S. Editorial. The surgeon's bib. *Surg., Gynec. & Obst.*, 99: 374, 1954.

Massive Gastrointestinal Hemorrhage of Undetermined Origin

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Over a period of ten years there were 67,909 admissions to the Methodist Hospital in Houston, Texas. In this group there were only 154 patients admitted with primary bleeding from the gastrointestinal tract. That is to say that in each 440 admissions, there was only one for this type of hemorrhage. The records indicated that about one-fourth of this number, thirty-seven, were admitted with massive hemorrhage. Patients with a massive hemorrhage, in these instances, required a transfusion of at least 3 pints of blood to stabilize the circulation. It is felt that it is unnecessary in this series to offer any other criteria for what may constitute massive bleeding. It is rare that one has any chance to measure or even give an accurate estimate of the amount of blood loss, the patient often entering the ward in a critical condition.

Allen [1] presented a study over a ten-year period ending in 1937. Of 72,447 admissions, there was an acute hemorrhage for each 313 patients admitted.

This does not have a great bearing on the presentation; however, it is noticeable by its absence that there was no bleeding of undetermined origin. In passing, it seems unusual that massive hemorrhage would come in this series from forty-five cases of gastric cancer.

Jankleson and Miller [2] made a survey on a larger series in which sixty cases of undetermined origin were found. In this group ten cases proved to be fatal, and even autopsy failed to reveal the cause in some.

The hemorrhages presented in this study numbered 154. (Table 1.) Of these cases, 120 were males and thirty-four were females. This is not unusual when compared with other

Table 1

	No. of Patients	Per cent	Deaths (%)
Sex Incidence			
Males	120	78	..
Females	34	22	..
Age Incidence (in decades)			
1–10	0	.....	..
11–20	4	.....	..
21–30	15	.....	..
31–40	29	.....	..
41–50	39	.....	..
51–60	26	.....	..
61–60	26	.....	..
71–80	15	.....	..
81–90	0	.....	..
Total:	154	.....	..
Origin			
Duodenal	97	6.3	..
Gastric:			
Ulcer	10	6.3	..
Carcinoma	9	5.8	..
Gastritis	1	.64	..
Esophageal varices	7	4.5	..
Jejunal ulcer	2	.13	..
Diverticulum	1	.64	..
Undetermined	27	18	..
Massive Hemorrhages			
Duodenal	12	32	11
Gastric	9	24	22
Esophageal	6	16	44
Undetermined	10	27	22

series. An attempt has been made to show age incidence graphically, there being more patients in the fifth decade. Generally, most series show more gastrointestinal bleeding from duodenal ulcer than from any other cause; ninety-seven patients (63 per cent) were in this category. A patient with a gastric ulcer will likely bleed to death more rapidly than one with a duodenal ulcer. Gastric bleeding in this series numbered twenty cases, nearly 14 per cent, with only nine of these represented by gastric carcinoma. Of the others represented in this figure, the twenty-seven of undetermined origin attracted the greatest attention. It is a fact that in most instances hemorrhage from an esophageal varix is about the most serious type the surgeon will encounter. The surgical handling of these patients is far from satisfactory, although with the several shunting procedures the prognosis has been improved. Others have advocated resection of the lower two-thirds of the esophagus. The massive bleeding from vague sources must be alluded to, and warnings given of the many pitfalls which might be encountered during exploration of these patients, for such will likely end in disappointment. How well one should realize the difficulty in locating the source of bleeding in the living subject, when even at autopsy, with the tract wide open, the bleeding site continues to be evasive.

Heuer [3] refers to one such case of persistent bleeding. At autopsy, only after the specimen was injected with colored fluid was a small aneurysm detected beneath the submucosa. How this parallels a case of ours is seen in the following case report:

Case I. A fifty-three year old Latin American woman was admitted because of large tarry stools and the vomiting of large amounts of blood, much of which was fresh with clots. There had been other bouts of bleeding six years previously, making it necessary to administer 8 pints of blood. Examination revealed the patient to be in shock, having a thin, quickened pulse of 120 and blood pressure of 55/38, low hemoglobin, and hematocrit of 20. Many transfusions were given to restore the circulation. In spite of this, she died on the fourth day. It was only after a determined search throughout the gastrointestinal tract, which was filled with old blood as well as new blood, that a small sclerotic aneurysm was found protruding from the mucosa on the posterior wall of the stomach.

Crohn [4] and others justify resection of a large part of the stomach for this vague masked bleeding. Such a procedure likely would have cured this patient, for the bleeding was in that part more often removed.

Hoerr et al. [5] make it easy for the surgeon to take his place in the management of these cases. To quote one of them, "The aim of the surgeon is basically simple; he should operate only on those patients that are bleeding to death despite medical treatment and transfusions." We would like to agree; however, there are those instances in which it is exceedingly difficult to foretell the outcome. When is one to decide that a patient will bleed to death?

Case II. A fifty year old white woman was admitted with a long history of pyrosis, finger point pain in the epigastrum, and many episodes of bleeding. She was admitted during an acute episode of bleeding. The hemorrhage was regarded to be so severe that she was subjected to resection of the lower two-thirds of the stomach and a sufficient portion of the duodenum to include what was thought to be an ulcer. The specimen failed to show an ulcer or a part thereof. On the seventh postoperative day bleeding began again and she went into mild shock. It was decided to perform exploration once more. The source was not accounted for, and 23 pints of blood were given over the next few days. The patient recovered without further incident.

Case III. A thirty-five year old woman was admitted because of vomiting large amounts of bright red blood. She came to the emergency room, having fainted at home several times. There had been one large tarry stool and several small ones. There was absolutely nothing in her history suggestive of the hunger pains of ulcer. She did have pain in the left upper quadrant of the abdomen and had been indisposed for several days with what she thought had been a "virus" infection. Some member of the household had procured and given her anapac, a remedy for colds containing antihistimine, aspirin, phenacitin and caffeine. Her first blood picture revealed a hemoglobin of 6.4 gm. per cent; red blood cells, 2.44 million per cu. mm.; hematocrit, 22; white blood cells, 12.3 thousand

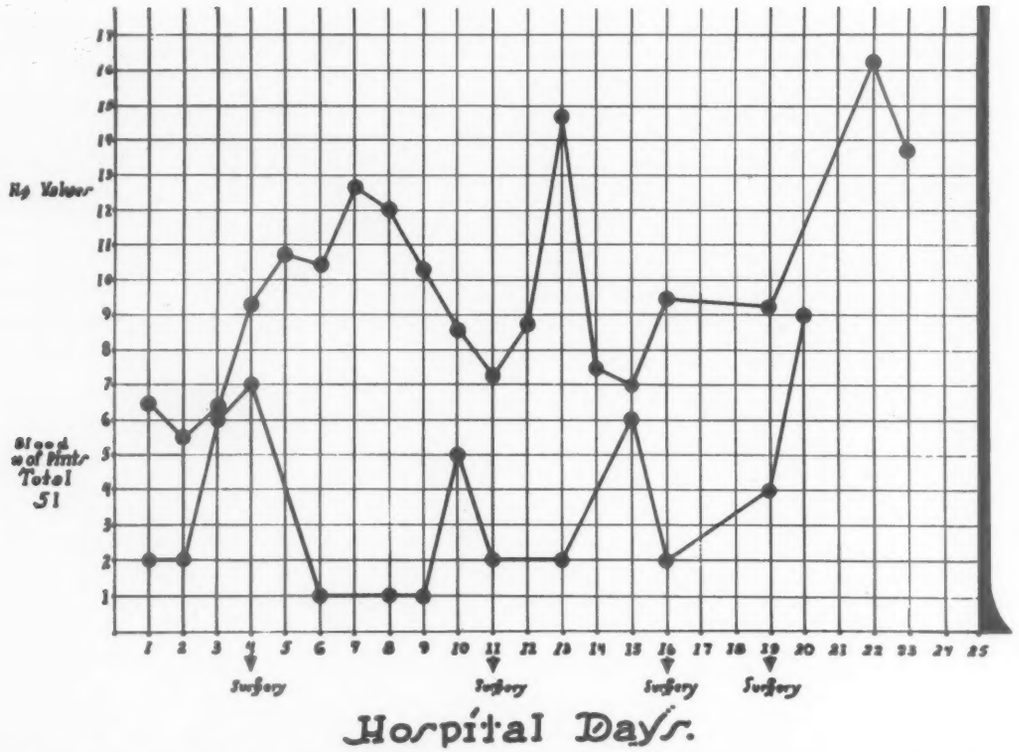

FIG. 1. Case III. Graft demonstrating the severity of hemorrhage. Four operative procedures were necessary before the bleeding was controlled.

per cu. mm. Even with this picture, her blood pressure was 112/76. The pulse was quick and thready.

At about this time we had experienced the death of a nurse with similar vague bleeding. There are various cases reported which stimulate one to be determined in finding the cause of this bleeding. Figure 1 helps to survey the course of this interesting patient (Case III) during her stay in the hospital.

The surgical and medical team made every effort to pool their resources throughout the management. In spite of the administration of about 4,000 cc. of blood in the first four days, the circulation would not stabilize. Hematemesis was so profuse that a barium swallow could not be utilized in search of esophageal varices. A double-balloon, triple-lumen tube was inserted into the fundus and lower end of the esophagus. Pressure thus exerted failed to control the bleeding. In our experience, this has often been evidence that the bleeding is not coming from the esophagus. After being unable to control the hemorrhage, exploration was performed. To our amazement, there was black blood in the intestine, but none in the stomach. A window was made into the stomach, and the mucosa explored. A finger was inserted into the pylorus, but failed to show any defect. A duodenal window was made and the mucosa was lavaged, but no source of bleeding was found. For four days the patient did very well; then she suddenly hemorrhaged again. The abdomen was explored once more. At this time another window was made into the stomach, higher up than before. Simultaneously, the esophagoscopist looked through his instrument, passing it into our field. We were failing again. Some of the team felt that there had been a change in the mucosa, but there were no bleeding points. Warm lavage was followed by closing. The patient had tolerated the procedure very well each time. It was not understood why, if this were a vague gastritis often referred to, it should cease. Each time surgery was performed a member of the team was in favor of resection in a manner advocated by Crohn [4]. On the sixteenth day it was evident that the patient's condition was worse again; bleeding was copious. Thromboplastin and oxycel® were used in lavaging, and the hematologist assured us she did not have a blood dyscrasia, the platelets being 200,000 and over. A surgical consultant, at this point,

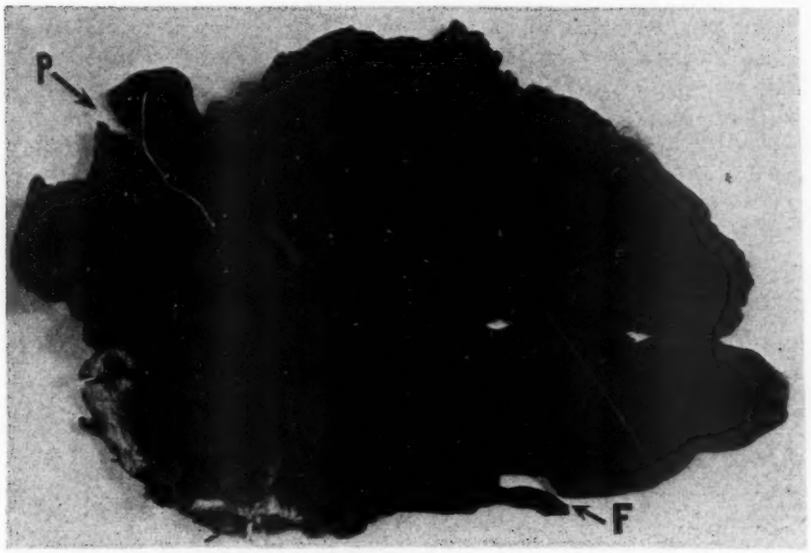

FIG. 2. Case III. Hemorrhagic process shown to involve chiefly the fundus of the stomach.

FIG. 3. Demonstrates the amount of mucosal reaction in a similiar case not subjected to intubation. Area involved is the lower third of the stomach.

suggested that the splenic, left gastric, gastroduodenal arteries (not hepatic) be separately tied, as was the inferior pancreaticoduodenal. This was done, and the patient did well until four days later when she hemorrhaged very profusely. At this stage, resection of the stomach was performed, leaving a small cuff of the fundus about 1½ inches below the esophageal orifice. She made an uneventful recovery from this time on.

It is really this specimen (Fig. 2) that prompted this presentation. The gross specimen shows all the disease confined to the fundus. It is well demarcated, however, only because we supported her until it had the time to do so.

The microscopic picture revealed a tendency to necrotizing and a massive infiltration of all the blood elements into an edematous mucosa. The mucosa nearer the pyloris was apparently intact. It could be held that the insult of the intubation may have aggravated this, but in Figure 3 a similar case is seen in which such intubation was not employed.

Of interest have been some of our efforts to study the circulation about the stomach.

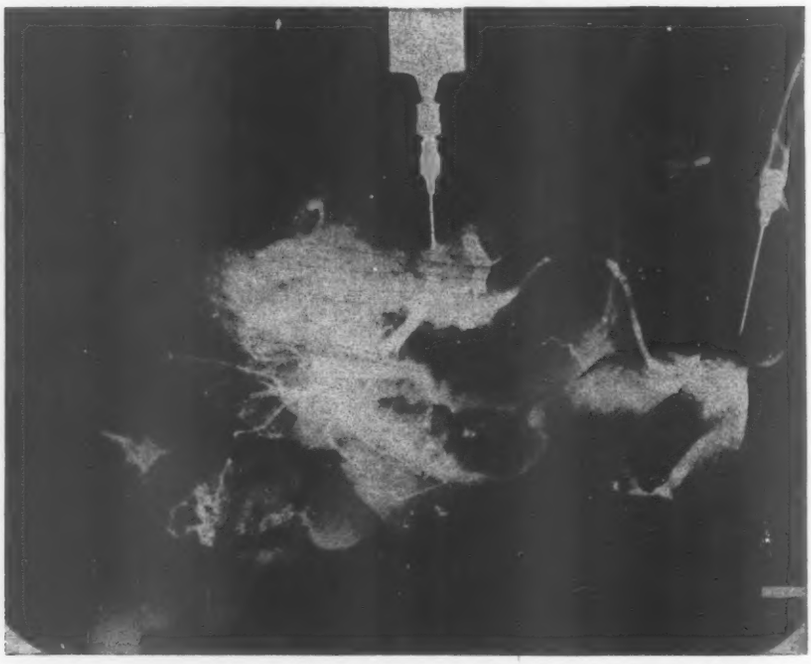

FIG. 4. A direct communication is shown to exist between the superior mesenteric and splenic arteries.

(Figure 4.) In fact, here is the blood supply to the fore- and mid-intestine, the celiac axis and superior mesenteric arteries. We have previously injected this specimen with methylene blue, ligating each and every bleeder. This was made while injecting sodium iodide into the superior mesenteric artery, the others all being occluded. A direct communication is shown between the superior mesenteric and splenic arteries. This is not new; we are warned of this, and Cunningham [6] lists many such anomalies.

SUMMARY

We have alluded to massive gastrointestinal hemorrhage in general, commenting on current approaches to the issue. We report three cases showing vague cause. One of these we tried to report in detail, showing photographs of the probable pathologic condition. We defined our treatment in the one case.

REFERENCES

1. ALLEN, A. Bleeding from the gastro-intestinal tract. *Internat. Clin.*, 4: 205–223, 1937.
2. JANKLESON, I. R. and MILLER, L. R. Gastro-intestinal hemorrhage of undetermined origin. *J. A. M. A.*, 145: 17–21, 1951.
3. HEUER, G. J. Massive gastro-intestinal hemorrhage. *New England J. Med.*, 235: 777, 1946.
4. CROHN, B. B., MARSHAK, R. H. and GALINSKY, D. Repeated gastro-intestinal hemorrhage without discernible explanation. *Gastroenterology*, 10: 120, 1948.
5. HOERR, S. O., DUMPHY, J. E. and GRAY, S. T. Place of surgery in the emergency treatment of massive upper gastro-intestinal hemorrhage. *Surg., Gynec. & Obst.*, 87: 338–342, 1948.
6. CUNNINGHAM, D. J. Structure and variation of blood supply to the stomach. In: Textbook of Anatomy, 7th ed., p. 591. New York, 1937. William Wood & Co.

Postgastrectomy Hemorrhage

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ONE of the most distressing experiences in surgery, fortunately infrequent, is to be called back to the hospital after a seemingly uneventful gastric resection to a patient vomiting copious amounts of blood, some brown and some red, past his Levin tube. The sight of the blanched, tremulous person studded with the perspiration of shock in a bed splotched with vomited blood, and attended by a second year resident looking askance, is enough to make one instantly wish he had never walked into an operating room.

Almost always, the bleeding point in postgastrectomy hemorrhage is located in the anastomotic suture line. Although dry at the conclusion of the operative procedure, bleeding may ensue from a vessel ligated at the time of the anastomosis or coagulated with the Bovie current. Pressure differentials in the postoperative period may initiate hemorrhage; the ensuing dilation of the stomach enhances the continuance of bleeding.

The conservative management of postgastrectomy hemorrhage has its hazards; and when bleeding does not stop with time, hope and gastric suction, reoperation is in order.

Surprisingly little reference to this problem is available in the literature, presumably because of its relative individual infrequency and the reluctance of surgeons to report this unfortunate complication.

In Lewis and Brown's [1] analysis of operating room deaths one of the reported patients died of secondary hemorrhage from a gastroenterostomy stoma.

Zinniger [2], in his review of complications of operations on the gastrointestinal tract, states: "Bleeding into a hollow viscus, for example, into the stomach, after partial gastrectomy, occurs but rarely. I can remember but one such case at the Cincinnati General Hospital in the past ten years, and this is the only one I have seen. In that instance, the treatment was similar to that of a bleeding peptic ulcer and the patient made an uneventful recovery."

Marshall [3] reported two postoperative hemorrhages resulting in fatalities proved at autopsy, and indicated that if large hemorrhages take place, reoperation should be considered as well as the need for opening of the stomach wall and a continuous interlocking suture of the stomal edges.

Colp and Weinstein [4] state that if intragastric bleeding does not abate with hot gastric lavage through an Ewald tube, exploration is mandatory. A liberal gastrostomy is suggested and they state that bleeding from the suture line can be readily controlled by reinforcing sutures.

Boles and Baker [5] state: "Most often vigorous blood transfusion therapy is all that is necessary but if bleeding is massive or continues for longer than 2 hours secondary operation may become necessary. Invariably the bleeding source is in the gastric closure or gastro-jejunal line. Gastrotomy with ligation of the bleeding vessel is the simplest procedure but if not feasible it may be necessary to take down part of the anastomosis."

Welch [6] states: "Hemorrhage from the suture line occurs immediately after operation or five to seven days after operation. The prothrombin should then be checked and Vit. K. administered." He states that bleeding usually stops; but if hemorrhage is massive or continues, the anastomosis is taken down and restored meticulously. If the bleeding occurs later, he suggests a gastrectomy and a continuous suture around the anastomotic line from within the stomach.

Thorek [7] stresses the methods of prevention of this unfortunate complication and mentions the method of dealing with it as the previously mentioned authors have outlined.

Shalkelford [8] advises removal of sutures of the anterior wall of the anastomosis.

Horsley and Bigger [9] report: "If the operation was a gastroenterostomy, the abdominal incision is opened. An incision is made through the anterior wall of the stomach and with the

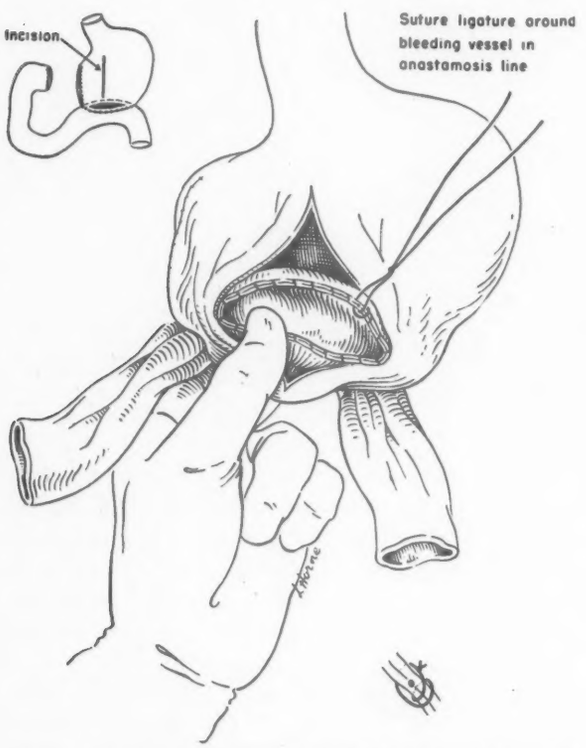

FIG. 1. Showing deliverance of bleeding stoma through secondary gastrostomy and suture ligation of bleeding vessel.

hand below the transverse colon the stoma of the gastroenterostomy is pushed up into the stomach. If the bleeding point is readily recognizable it is sutured or if there is any uncertainty the entire margin of the stoma is whipped over with a continuous suture of catgut. Somewhat the same procedure can be adopted if the bleeding follows a gastrectomy or pyloroplasty."

In the experience of the author, reoperation has been performed in three such cases using the technic of delivering the anastomosis through a gastrostomy incision. The technical feasibility and simplicity of this maneuver is striking and deemed worthwhile calling to general attention.

A typical procedure for the treatment of postgastrectomy bleeding could be described as follows:

The abdomen is opened through the recent operative wound. Upon opening the peritoneal cavity the greatly ballooned, bluish stomach remnant, swollen to unexpected proportions, is generally immediately evident. The intestines are packed away and laparotomy tapes placed to prevent contamination of the peritoneal cavity from spillage of the stomach contents. A basin or several large cups are made available, and with one held against the wall of the stomach segment a gastrotomy, preferably vertical, is made in the anterior gastric wall and part of the gastric contents evacuated into the basin or cup. Without spending undue time evacuating the entire stomach, the left hand is placed under the anastomosis and the anastomosis is inverted into the gastrotomy wound. In this manner the entire suture line may be visualized from the mucosal surface, and when wiped with a wet tape the bleeding vessel or vessels become immediately evident. A figure-of-8 suture is all that is needed to control such a bleeder. The entire suture line is carefully inspected, and with assurance that the bleeding has been controlled, the stoma is returned to the inside of the stomach and the small gastrotomy incision closed. (Fig. 1.)

CASE REPORTS

CASE 1. Mr. A. S. was admitted to the Mt. Zion Hospital with marked gastric hemorrhage. There was a long history of alcoholism, periodic in nature. The patient continued to bleed profusely during the night, and in the morning underwent a gastric resection. Approximately two-thirds of the stomach was removed, including the first 2 cm. of the duodenum. The resected tissue revealed a large ulcer perforating in the duodenum into an area of aberrant pancreatic tissue just past the pylorus. The pathologic report showed ulceration in two vessels in the aberrant pancreatic tissue. The operation was performed without difficulty, and at the finish of the procedure the patient was in good condition, no obvious bleeding coming from the stomach tube. At approximately 4:00 P.M. the patient started to bleed from his stomach, vomiting copious amounts of dark red and bright red blood. He vomited continuously until 2:00 A.M. despite continued transfusion and was then taken back to surgery. During the administration of the anesthetic, the patient went into cardiac arrest.

The chest was opened through the previous transverse abdominal wound, the incision being extended upward and the hand passed beneath the ribs and above the diaphragm at the layer the diaphragm entered the abdomen. The heart was rhythmically massaged and the cardiac function restored. The abdomen was then opened and the stomach was found to be immensely distended with blood. Tapes were sewn to the anterior gastric wall to prevent spillage. The anterior gastric wall was then opened, the clots evacuated and the anastomotic line delivered through the incision. A small bleeder was present in the anastomotic line. Bleeding also was encountered high in the stomach from the distention of the stomach with bloody material, and this was controlled by the placement of a Sengstaken tube in the upper portion of the stomach. The gastric wound was closed and the abdomen was closed in layers. The patient made an uneventful recovery from this traumatic episode.

Case II. H. G., a twenty-eight year old Mexican laborer, was admitted to Mary's Help Hospital with a history of recurrent bleeding from a previously demonstrated duodenal ulcer. Gastric resection was performed by Dr. G. F. Norman. Immediate postoperative recovery was uneventful. On the tenth postoperative day the patient started vomiting and radiographs revealed herniation of a loop of bowel through the mesocolon with obstruction of the jejunum. The patient was reoperated upon on this day. The mesocolon, which had torn away from the stomach wall, was resutured after the bowel had been displaced below the suture line. The patient did well for the ensuing five days and then suddenly started to hemorrhage large amounts of blood. He was taken back to surgery on the sixteenth postoperative day. The abdomen was opened through the original incision. On opening the abdomen the stomach was found to be markedly distended with blood. Tapes were sewn to the anterior portion of the stomach, the stomach was opened, the anastomoses were delivered through the gastrostomy wound and a bleeding vessel was ligated by means of placement of the figure-of-8 suture. The gastric wound was closed and the abdomen was closed with through and through sutures of stainless steel wire. The patient ran an extremely high temperature for the ensuing three days and then died suddenly, apparently from a pulmonary embolism. Autopsy was not performed.

Case III. A sixty-six year old white man had complained of abdominal distress and dyspnea for two to three weeks. A history was given of subacute bacterial endocarditis four years previously, with cardiac decompensation and maintenance on digitalis since that time. The day prior to admission he passed a tarry stool and later vomited bloody material. Hemoglobin taken at a suburban hospital was reported at 60 per cent. Physical examination revealed cardiac enlargement and aortic insufficiency. The patient was supported by blood transfusions and gastric suction, and appeared to have stopped bleeding; however, forty-eight hours later massive gastric hemorrhage resumed and an operation was scheduled. The stomach was found to be moderately dilated and filled with clotted blood. An acute, bleeding gastric ulcer was found. Subtotal resection was performed. The liver was normal in appearance and no varices were noted in the esophageal area. Following the transection of the duodenum it was thoroughly explored and no evidence of bleeding was found to be present. On section of the stomach a small, acute ulcer on the posterior surface was located halfway between the cardia and pylorus. A four-layer anastomosis, anastomosing the proximal jejunum to the cut edge of the stomach, was performed. At the conclusion of the procedure the anastomotic lumen was adequate and no bleeding was noted. Following the patient's return to bed after the gastric resection, and after an hour's interval, a large amount of blood came from the nasogastric tube. Bleeding continued despite repeated transfusions and re-exploration was decided upon. Surgery was performed starting at 11:40 P.M. and ending at 2:00 A.M.; the secondary procedure was performed at 11:45 A.M. and ended at 12:45 P.M. The previous incision was opened and the stomach was found to be distended with clotted blood. A transverse incision was made into the anterior gastric wall approximately 1½ inches above the stoma, and the stoma was manually delivered through the gastrostomy wound. The bleeding vessel was clamped tight quite easily and ligated. At the close of the ligation the stomach appeared to be quite dry. The gastrostomy was closed with two layers of No. 40 cotton and the abdomen was

closed with through and through surgeloy sutures. The patient made a satisfactory recovery in spite of his rather poor condition at the end of the second procedure, and was discharged from the hospital on the thirty-first postoperative day in good condition.

SUMMARY

Postgastrectomy hemorrhage if persistent may be quickly and successfully treated by gastrotomy of the gastric stump with delivery of the stoma through the gastrotomy for ligation of the bleeding vessel. Three illustrative cases are reported.

Acknowledgment: Thanks are given to Dr. G. F. Norman and Dr. Harold Lindner for allowing me to report their cases.

REFERENCES

1. Lewis, K. M. and Brown, S. E. G. An analysis of the operating room death on a general surgical service. *Surg., Gynec. & Obst.*, 100: 397, 1955.
2. Zinniger, M. M. Complications following operations on the gastrointestinal tract. *S. Clin. North America*, 25: 1153–1166, 1945.
3. Marshall, S. F. Post-operative complications following subtotal gastrectomy. *S. Clin. North America*, 17: 705, 1937.
4. Colp, R. and Weinstein, V. Post-operative complications following subtotal gastrectomy for peptic ulcer. *S. Clin. North America*, 35: 383–388, 1955.
5. Boles, T. and Baker, J. W. Pre-operative and post-operative management of patients with gastric and duodenal lesions. *S. Clin. North America*, 34: 1391–1402, 1954.
6. Welch, C. E. Surgery of the Stomach and Duodenum, p. 291. Chicago, 1951. Year Book Publisher.
7. Thorek, M. Surgical Errors and Safeguards. Philadelphia, 1943. J. B. Lippincott Co.
8. Shalkelford, R. T. and Deyor, H. S. Surgery of the Alimentary Tract, vol. 1, p. 499. Philadelphia, 1955. W. B. Saunders.
9. Horsley, J. S. and Bigger, I. A. Operative Surgery, vol. 2, p. 886. St. Louis, 1940. C. V. Mosby Co.

A Statistical Analysis of the Fluid and Electrolyte Requirements of Surgical Patients

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IN recognition of the extreme variability in human biochemical response to the stress of illness and trauma, legitimate concern has been raised against proposals for a standard solution for parenteral alimentation. We contend, however, that a solution of electrolytes known to be useful is more reasonable and safe than .9 per cent saline and glucose and water. Such a mixture or a polyionic solution cannot replace careful observation of plasma levels nor can it replace meticulous management of known losses of these constituents. However, it is the conclusion from this study that a mixture of electrolytes which does not exceed the minimal average requirement of a surgical patient is a more reasonable starting base line than one containing only an excessive amount of sodium chloride.

METHOD OF STUDY

While endeavoring to maintain equilibrium under all circumstances, balance studies were carried out on 102 patients for a total of 488 patient days. From these balance studies an attempt is made to determine the requirements of a surgical patient. Study series were set up on patients receiving only parenteral alimentation without oral intake of any kind.

Electrolyte input calculations are determined from a knowledge of the content of the solutions given by vein. Calculations of fluid needs have been made on the basis of the previous days' urine output, suction or other drainage losses, and a calculation of the insensible water loss based on the Du Bois tables including a calculation of 40 per cent increased metabolism for bed activity and an additional 8 per cent addition for each degree of temperature elevation above normal. Urine is collected by a continuous drainage from an inlying catheter. An enema had been given the day before the study period and therefore no stool losses occurred. Administration of fluids for each twenty-four hour period has been distributed throughout the entire twenty-four hour period with as steady a flow as was mechanically possible. This around-the-clock input of intravenous alimentation is accomplished by use of an inlying polyethylene venous catheter.

Output calculations on urine, suction returns and on other drainage losses are determined for nitrogen, sodium, potassium and chloride.*

Objection to grouping together of surgical patients is anticipated since many would desire information on severity, type of illness and other aspects of each individual patient. To a statistician it seems more logical to see orderliness from number rather than to expect the clinician to build within his own mind an hierarchy of personal opinion in which he remembers only the cases which support his particular beliefs. Further, it is more logical in the light of the variability present in even these large numbers that small groupings of patients could give rise to almost any desired opinion depending upon the sequence of occurrence.

These data have been subjected to exhaustive statistical analysis for three periods of time with respect to surgery. The results are not necessarily independent of each other since the same patients are included preoperatively as well as postoperatively. The knowledge of

* Nitrogen determination by Kjeldahl method, sodium and potassium determination by Beckman B flame photometer, chloride quantitative determination by mercuric nitrate titration.

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this relationship would be helpful but not necessarily essential since the administration of any element at a given point in time will be related in some manner to its excretion in subsequent periods of time. Keeping this decreasing relationship over time in mind, it seems logical that the use of a standard solution with a nearly constant rate of application will minimize the day-by-day fluctuations of input and output of any given element.

In this analysis we have considered as variables, nitrogen, potassium, sodium, chloride and fluid. The following simultaneous solution of sets of two linear equations for each of five variables for the three divisions of data is a true solution only when the three divisions of data are independent and the variables themselves are independent. What effect the variables have on one another may be impossible to determine since controlled experiments on sick patients are likewise impossible. Similarly, experimentation on "well" patients would be illogical since an influence of one kind of object to another population of objects cannot be justified. Nevertheless, it is believed that regression analysis with the intent of estimating a patient's output at any intake would be more informative than the mean and standard deviation.

Each of the variables is considered an entity. A regression line for output on input was computed by the least-squares method. A line of equivalence (output equaling input) was constructed and its intersection with the regression line was found to be 18 gm. for nitrogen, 90 mEq. for sodium, 70 mEq. for potassium and 90 mEq. for chloride, as indicated in an earlier paper [1]. These values were considered to be the over-all daily requirements throughout the entire surgical period. Since a considerable variation exists between the three periods related to surgery (preoperative, day of surgery and postoperative), even an average of the total will in some aspects exceed the actual requirements of an individual patient in a specific period.

OBSERVATION AND ANALYSIS

The figures in this study were analyzed from the point of view of three phases of surgery—the preoperative period, the day of surgery and the postoperative period.

The regression equations for the three divisions of data are indicated in Table I. These are solved simultaneously with the line of equivalence to yield the amount of each variable that should be administered daily to a surgical patient.

TABLE I

Variable	Values	Total Average Daily Need (retention of administered substances)
	Preoperative	
Nitrogen...	$N_o = 6.5 + .53\ N_i$	13.9 gm.
Potassium..	$K_o = 32. + .24\ K_i$	41.8 mEq.
Sodium.....	$Na_o = 70. + .33\ Na_i$	104.9 mEq.
Chloride....	$Cl_o = 64. + .70\ Cl_i$	79.0 mEq.
Fluid.....	$F_o = .98 + .61\ F_i$	2.50 L.
	Day of Surgery	
Nitrogen...	$N_o = 5.7 + .62\ N_i$	15.5 gm.
Potassium..	$K_o = + .46\ K_i$	77.5 mEq.
Sodium.....	$Na_o = + .34\ Na_i$	99.8 mEq.
Chloride....	$Cl_o = + .49\ Cl_i$	92.9 mEq.
Fluid.....	$F_o = + .34\ F_i$	2.96 L.
	Postoperative	
Nitrogen...	$N_o = 14.3 + .33\ N_i$	21.5 gm.
Potassium..	$K_o = 44. + .26\ K_i$	58.9 mEq.
Sodium.....	$Na_o = 35. + .47\ Na_i$	66.6 mEq.
Chloride....	$Cl_o = 46. + .33\ Cl_i$	68.5 mEq.
Fluid.....	$F_o = .75 + .75\ F_i$	3.01 L.

NOTE: o = output
i = intake

From these figures we see that the average daily requirements are not identical in the three phases of surgical care.

If we assume that the relationship between the variables is linear and that the effects are additive, then the results here may be very good. Proceeding on these very important assumptions, we can determine the following ideal solutions for intravenous use. (Table II.)

Half the patients had outputs that differed from their intakes by no more than the amounts indicated in Table III. These could be used as estimates of the variability of all surgical patients coming into this practice.

The adjustment of a standard solution by the use of stock concentrates, for patients who are obviously not in balance, could be made

TABLE II

Period	Total Fluid Intake/24 Hours (L.)	Nitrogen (gm./l.)	Potassium (mEq./l.)	Sodium (mEq./l.)	Chloride (mEq./l.)
Preoperative	2.5	5.6	16.7	42.0	31.7
Day of surgery	3	5.2	25.8*	33.3	30.9
Postoperative	3	7.2	19.6	22.2	22.8

* It may be desirable to leave potassium out on the day of surgery until urine flow is established.

keeping in mind that a commendable discrepancy from the standard would be less than one probable error of estimation for each variable. (The P.E. of estimate is the empirical band about the regression line within which half the patients are expected to lie.)

TABLE III

Variable	P.E. of Estimate
Nitrogen	4.4 gm.
Potassium	22 mEq.
Sodium	60 mEq.
Chloride	50 mEq.
Fluid	650 ml.

COMMENTS

From these analyses we see that potassium, sodium and chloride have estimation intervals of nearly the same magnitude for each of the three divisions of the data. This similarity of the intervals of estimate is the same kind of similarity that was found among the correlation coefficients. Hence we see that for many who desire correlation analyses, the results would have been the same but much less information would have been given. Further, too often correlation is associated in persons' minds with causation. No such implications are made in this paper and any statements involving less than third or fourth order partial coefficients would be telling only a partial truth.

From the standpoint of practical usage of polyionic fluids for parenteral alimentation, the safest base line or starting point solution should be one containing the minimum quantity of each electrolyte for any of the three periods of study.

As indicated in Table II, ideally three separate solutions should be employed to meet the base line requirements in the preoperative period, day of surgery and postoperative period. A more practical approach suggests a single solution containing 6 gm. of nitrogen, 17 mEq. of potassium, 22 mEq. of sodium and 23 mEq. of chloride per liter. Stock concentrates of the three major electrolytes could then be employed to add to the basic solution as becomes necessary.

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REFERENCE

1. STRICKLER, J. H., RICE, C. O. and TRELOAR, A. E. Observations on the relationship of output to intake for total fluids, nitrogen, potassium, sodium, and chloride for perisurgery patients under parenteral nutrition. *Surgery*, 39: 152, 1956.

The Case for Motion and Time Study in Surgery

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The use of motion and time study in industry has brought many benefits over the years. The methods for performing both manual and machine work have been steadily improved. Machines, tools, work places and the time required to perform specified tasks have all been standardized. Workmen have learned to do more and earn more in a given period of time. Similar benefits can be derived from motion study in surgery. Motion study is capable of: (1) improving operating room layout and equipment design; (2) achieving better preoperative planning;* (3) identifying all unproductive† and potential delays‡ and unnecessary motions§ in the surgical procedure itself so that they may be eliminated; (4) developing the most efficient procedures to serve as standards; and (5) suggesting means for improving the teamwork of the surgical staff, utilizing standardization to the greatest possible extent.

Although the benefits to be derived from a serious application of motion study to surgery are considerable, objections to its use arises on three distinct bases: (1) the idea that surgical efficiency, as measured in terms of the time required to perform an operation, is inconsistent with the essential purpose of surgery defined in terms of the maximum welfare of the patient; (2) the idea that surgery is so variable that the application of time study is physically impossible; and (3) the record of the past which shows that, whenever time study has been applied, it has failed to produce significant results in practice.

Any modern advocacy of time study in surgery can be based only on the realistic refutation of these specific objections. This is the purpose of this paper. Before any argument can be presented, however, it is necessary to digress somewhat for the purpose of establishing a common understanding of the philosophy and technics of motion and time study.

PHILOSOPHY OF MOTION AND TIME STUDY

Motion and time study are separate but related technics which constitute successive phases in determining the best motion pattern for performing any manual task. Motion study combines analytic and synthetic technics for constructing motion patterns. Time study provides a means of choosing between competing patterns for performing the same task.

The philosophy underlying motion and time study is that there is always one method for doing a job which is superior to all competing methods. If there are six or seven methods for doing precisely the same thing, they are not likely to be equally good. The differences which

* Preoperative planning is planning completed before the operation begins as opposed to the planning done as the surgery proceeds.

† A delay is defined as an incident which, for a time, prevents the surgeon from performing his next planned act. Not all delays are unproductive however. By spending an extra hour making a careful dissection of the common duct in a gallbladder operation, disastrous accidents may sometimes be avoided. Such work, when it is unforeseen, may be considered a delay, but if so, it is a productive delay which should not be eliminated. An unproductive delay is one which contributes nothing to the welfare of the patient.

‡ A potential delay is defined as an instance which could produce an actual delay but does not. If the scrub nurse foresees the need of an instrument not available in the room, she might send for it and receive it before the surgeon needed it. This would be considered a potential delay. Potential delays cause confusion and uncertainty in the operating room and, under less favorable circumstances, would cause actual time loss.

§ Unnecessary motions are motions which contribute nothing toward the purpose of the surgeon.

exist between competing methods ought to be eliminated in favor of a standardized method provided it is demonstrably superior to all of them.

Despite the obvious logic of this philosophy, most surgeons argue that it should not be applied to surgery. They know from experience that there are significant differences between patients, surgeons and surgical facilities. Quite rightly they support a variety of technics so that they may select the one most appropriate to the conditions facing them in any specific case. However, the philosophy of the "one best way" does not mean that there should be only one precedure for performing an aortic commissurotomy nor does it mean that interrupted suturing should replace, or be replaced by, continuous suturing in a given procedure. What it does suggest is that having decided upon a given procedure for aortic commissurotomy or having decided upon interrupted suturing, one particular set of motions may be found which will be more effective for the purpose in view than any other set. The philosophy is the same, but it is related to elements much smaller than suturing, for example, as an element of the entire procedure. It applies to surgery, as it does to all work, only after it has been decided precisely what is to be done. Motion study never will be able to tell the surgeon what procedure to use in a given case, but it may well suggest better ways of performing each element of the procedure after it has been selected.

Time study is appropriate as a means of choosing between competing motion patterns only where time is the accepted basis for choosing one method in preference to another. At first glance it may appear that time is not an appropriate criterion for choosing between motion patterns in surgery. It seems contrary to the generally accepted idea that the surgeon should take the time to do all that can be done for the patient. To many, motion and time study appears to advocate haste and short cuts. This is simply not the case. What it proposes is the elimination of all unproductive delays and unnecessary motions. These are delays and motions which contribute nothing to the welfare of the patient. They are sheer waste and should be eliminated because the time thus saved can be made to contribute to the welfare of the patient either by: (a) increasing the amount of useful surgery which can be performed in a given time, or (b) shortening the operation and thus reducing exposure to anesthesia and shock. In cardiovascular surgery, especially, time is often a critical factor. Surgeons resort to the use of donors, artificial hearts and hypothermia in order to extend the time for the performance of their work. It is obvious that a more efficient procedure which enables the surgeon to do more work in a given length of time accomplishes the same result in a simpler and more desirable manner.

TECHNICS OF MOTION AND TIME STUDY

It would serve no purpose to attempt to outline here all the technics of motion and time study. Only those of special value to the study of surgery will be discussed.

Both motion and time study can be performed crudely or precisely. What makes the difference is the size of the elements which are considered the unit variables in the procedure under study. Each element in a study is treated as though it were an indivisible unit of work and is recorded and timed separately. If the elements are small (reach, grasp, move, etc.), the study is considered precise. If the elements are large (enter room, talk to assistant, move into position, etc.), the study will be comparatively crude. The objectives in view and the nature of the procedure under study determine which kind of study is the more appropriate.

For improving operating room layout and for improving preoperative planning, fairly crude methods are adequate. For the first, all that is necessary are elementary flow studies. For the second, ordinary delay studies are sufficient.

The end products of a flow study are: (1) a chart which relates, on the basis of time, the functions performed by the members of the group, and (2) a diagram of their movements about the room. The most frequently used paths are easily detected and methods of shortening them can usually be found. Frequently one trip may be made to serve more than a single purpose. The result is a simplification of the procedure in terms of sheer physical movement and often, also, in terms of the number of assistants involved.

A flow chart is made from data which require the continual observation of everyone involved throughout the entire surgical procedure. For this purpose a motion picture which accounts for the activities of everyone throughout the entire procedure is ideal. It is difficult to make

such a picture, however. Motion picture cameras use film at the rate of approximately 1,000 frames per minute and, for this reason, cannot store sufficient film for a procedure of even moderate length and, quite rightly, surgeons do not want to be bothered with additional persons in the operating room and the reloading of cameras. This difficulty is overcome by the method of memo-motion. A film is made at the rate of about 120 frames per minute. Although not everything is recorded, an adequate record of the gross movements of everyone is obtained and reloading of the camera is eliminated. A special camera would have to be designed with a wide angle lens to cover the entire operating room from one point and be completely automatic except for starting and stopping. It would be mounted on a specially constructed mount and would not require the introduction of additional personnel into the operating room during the operation.

A large percentage of the delays which occur in surgery are the result of inadequate preplanning, instruments are wanted and are not available, equipment fails to function as it should, important services are not scheduled. Almost all these delays can be eliminated by proper attention to preplanning (including pretesting). Preplanning can be reduced to a system and carried out almost automatically by nurses and by administrative personnel. Preoperative planning may be significantly improved by simple delay studies made by an observer with pencil, pad and stopwatch. All that is necessary is that whenever a delay or potential delay occurs, the observer record it along with its cause and the time it occurred and ended. Consultation with members of the surgical team is frequently necessary to determine causes accurately. The writer has made a number of studies of this kind with considerable success.*

In order to study equipment design, to identify unnecessary motions in the surgical procedure itself, to develop efficient procedures and to suggest means of improving teamwork, motions must be observed in minute detail. A much more precise study is needed. The procedure used in industry is micromotion study. Films are made at high speed (about 2,000 frames per minute) and examined at slow speed, or frame-by-frame, in order that motion patterns may be dissected and better ones synthesized. The difficulty attendant upon applying this technic in surgery arises from the rate at which film is used. Either the camera must be reloaded quite often, and for continuity of sequence this means using a pair of cameras, or only a small part of the operation can be photographed. It appears that the second alternative is preferable and that micromotion study of the most critical phase of the operation would be most helpful. The camera would be automatic and specially mounted so as to be, in all respects, as unobtrusive as possible. The films, supplemented by the notes of an observer would be analyzed under laboratory conditions. Suggestions would be made for eliminating unnecessary motions or for replacing less efficient ones with more efficient ones. Standardized surgical procedures will emerge eventually and films can be produced for teaching them.

With respect to teamwork in surgery, very little is known. Training, devotion to a common cause, professional ethics and authority seem to be factors, but more study is needed to be certain and to establish the relationships between them and the contribution of each to the whole. The films which will be obtained ought to throw considerable light upon this subject when studied by persons especially competent in the study of group dynamics.

REFUTATION OF OBJECTIONS TO THE USE OF MOTION AND TIME STUDY IN SURGERY

The first objection, that surgical efficiency as measured in terms of the time required to perform an operation is inconsistent with the essential purpose of surgery defined in terms of the maximum welfare of the patient, has already been answered. The fact is that unproductive delays and unnecessary motions are sheer waste and should be eliminated and the time so gained can be made to contribute materially to the welfare of the patient.

The idea that surgery is so variable that motion and time study cannot be applied to it is quite erroneous. This was the cry of most industries when motion and time study was being introduced during the nineteen twenties. Each claimed to be different and more complicated than the others and argued either that time study could not be applied in their case

* Experimental studies showed time lost due to delay to be distributed as follows: 46 per cent, imperfect teamwork; 40 per cent, poor preoperative planning; 7 per cent, incomplete training; 3 per cent, poor design of equipment; 4 per cent, other; 73 per cent of the potential delays were found to be due to poor preoperative planning.

or would do no good even if it could. Each was proved wrong. It is true that surgery is highly variable, but much of the variability is not inherent in the surgery itself. Rather, it is due to the fact that various schools of medicine and nursing teach different methods for doing the same thing. The methods taught by any given institution tend to become traditional and the difficulty of revising them increases in proportion to their years of use. If acceptable criteria could be developed for evaluating these methods, subsequent comparisons would undoubtedly reduce their numbers. Even so surgery would remain highly variable by reason of the variability in the structure of human beings and in the illnesses which afflict them. Even this variability is not so great as it at first appears, however. It is, in fact, the constant recurrence of a limited number of diseases which makes possible the classification of illnesses and the development of standard procedures for treating them. Nevertheless, the variability inherent in surgery is greater than in most industrial operations and demands special consideration in motion and time study.

In order to minimize the variability characteristic of surgical procedures, operations may be divided into four phases: (1) preparation of the operating room—in which the operating room is set up, instruments sterilized, equipment connected, etc.; (2) preparation of the patient—administration of anesthesia, draping, etc.; (3) the surgical phase—in which the actual corrective surgery is performed; the surgical phase begins with the initial incision and ends with the closing of the incision; (4) the clean up—removal of the patient from the operating room, the cleaning and sterilizing of the room itself, removal of all soiled equipment, etc. Phases one and four are not more variable than many industrial operations and can be standardized with respect to procedure. Phase two is less susceptible to standardization because of the administration of anesthesia. However, the draping and many other incidental functions performed at this time may be readily standardized.

The third, or surgical phase, of the operation is a non-typical phase in the sense that the surgeon generally must make decisions about what he will do and how he will do it as he goes along. The procedure cannot be standardized as a whole. It can be standardized by parts, however, so that when a choice is made, a standardized procedure may be followed in implementing it. The choice between silk and catgut as a suturing material as well as the choice between continuous and interrupted suturing will depend upon the nature of the case but, when these choices have been made, one technic for implementing them may be found which will be demonstrably superior to all the others which are tried. There is then a powerful argument for bringing this technic to the attention of every resident in surgery. Thus motion study should be applied on a research basis to the activities of the chief surgeon even in this non-typical phase of the operation. Moreover, many persons contribute their efforts during this phase of the operation and some of them perform duties which are relatively unaffected by changes in direction decided upon by the surgeon but dictated, in the final analysis, by the condition of the patient. The activities of these persons should be subjected to analysis and standard procedures developed wherever possible.

In industry, where the complete standardization of each operation is possible, great benefit has been derived. The standardization of facilities and instruments has made possible the standardization of methods and a resulting increase in productivity and the simplification of training and of maintenance. While it is unlikely that many surgical operations can be completely standardized, most are open to at least partial standardization. Two phases, the first and fourth, can almost always be standardized. Limited standardization of the second and third is possible also in many cases. Even a limited amount of standardization produces benefits too great to be ignored. It greatly reduces the variety of facilities, instruments and accessory equipment used, and thereby facilitates the training of surgeons and nurses. As standard equipment is made more widely available it becomes possible for all concerned to become more familiar and efficient in its use. In time of emergency, it is easier for surgeons, trained and practicing in widely scattered geographic areas, to be of maximum service immediately in a new area.

The record of the past appears to show that whenever motion and time study has been applied to surgery it has failed to have significant practical results. The appearance is quite misleading, however. There is an important distinction which must be made between using the results and using the methods of motion study in surgery. The method of motion

study, applied to industrial tasks, has produced a number of rules, generally known as the principles of motion economy, which are applicable in industrial work. It is the application of these rules (the results of motion study) to surgery which is to be criticized in most of the previous work in this area. However, the studies by Gilbreth and those by Lawrence and Berry are not open to these criticisms as they were real applications of the method of motion study to surgery. Nevertheless their work had only minor effects on surgical procedures. It appears that the following are the principal reasons for their failure: (1) They failed to develop adequate means for communicating their findings to the medical profession. (2) Their methods, and particularly their equipment, were inadequate. (3) The data acquired were not sufficient to support their conclusions.

It seems likely that these difficulties can be overcome in the following ways:

1. After due care has been taken to establish the significance and usefulness of the results, the fullest publication in pertinent medical journals should be sought. However, technical reports in medical journals cannot be relied upon as the only means of communication. Practicing surgeons and surgical nurses find it most difficult to change their methods, especially when the change appears peripheral or insignificant. They must concentrate upon immediate and important matters and cannot be distracted by trying to remember to perform some minor function in a new way. For this reason it is believed to be most efficient to introduce new methods by teaching them to residents rather than to practicing surgeons. The disadvantage to this approach is that new methods do not appear in practice for some years after they have been developed. This procedure is recommended as being sure even though somewhat slow. Thus recommended improvements in procedure should be submitted to the American College of Surgeons as the first step toward adoption by the medical schools.

2. A surgical operation is quite different from an industrial task in many respects. It is essentially a team effort in which control is a result of devotion to a common cause; it is not subject to mechanical control. The team is quite a large one made up of specialists, each with a specific duty to perform. One cannot study the whole by studying the parts for the parts, by themselves, are meaningless. The analyst must be able to observe the whole team all the time. He must be able to analyze the way in which its members work together. The methods of motion study used in industry are, for the most part, means for studying individual performance. They are, therefore, basically unsuited to motion study in surgery. The methods of Gilbreth and those of Lawrence and Berry suffered from the defects inherent in the methods of motion study in use at the time their studies were made. However, recent developments have produced methods and equipment, particularly photographic equipment, suited to the special requirements for studies in surgery.

3. The problem of acquiring data sufficient to support conclusions remains a difficult one because of the great variety of surgical procedures. Single variable experimentation is, of course, impossible and it will be necessary to study a sufficient number of operations to make possible some degree of statistical control. The best guarantee that this will be accomplished would be the establishment of a research project with assurance of adequate funds for a number of years.

As surgery is subjected to analysis, better surgical procedures and better methods for teaching them will be developed. The skills of surgeons and their highly trained assistants as well as the surgical facilities of hospitals will be used more effectively. By these methods the costs of surgery can be reduced or, conversely, more surgical care can be provided for the same cost. Neither the medical profession nor the public, which in the final analysis pays all the medical bills, can afford to overlook the savings which an intensive and prolonged research program of motion study in surgery is capable of producing.

REFERENCES

1. Dickenson, R. L. Standardization of surgery. *J. A. M. A.*, 63: 763, 1914.
2. Gilbreth, F. B. Motion study in surgery. *Canad. J. Med. & Surg.*, 40: 22–31, 1916.
3. Lawrence, W. H. and Berry, C. H. Rhythmic surgery; arrangement of an operating room. *Am. J. Surg.*, 43: 669–747, 1939.
4. Lawrence, W. H. and Berry, C. H. Rhythmic surgery. *Am. J. Surg.*, 41: 393–398, 1938.
5. McCarty, F. B. Motion study in surgery. *Am. J. Surg.*, 179–209, 1944.
6. Pool, E. H. and Bancroft, F. W. Systematization of a surgical service. *J. A. M. A.*, 59: 1599, 1917.

Titanium for Femoral Head Prosthesis

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RECONSTRUCTION arthroplasty of the hip using a femoral head replacement has lost considerably in popularity since the procedure was first introduced. The recent symposium [1] on femoral head replacement prosthesis certainly suggests that there are many complications and the end results are far from expectations.

At present vitallium® and stainless steel prostheses are being used. The acrylic and nylon prostheses have proved to be unsatisfactory [1]. Some of the failures have been due to actual breakage of the stainless steel prostheses, but it seems that the greatest difficulty arises from the fact that the prostheses become loose in the bone, particularly if the Judet type is used. An area of reaction in the form of demineralization about the prosthesis is usually seen. This would suggest that stainless steel is not an ideal material for a prosthesis. Everyone is familiar with the ease with which a stainless steel Smith-Petersen nail or a stainless steel screw can be removed after being in bone several months. This looseness of the prosthesis can account for the feeling of instability that some patients describe to their surgeons. A loose stem type prosthesis, by riding up and down with every step, can eventually produce an erosion and protrude on the outer side of the femoral shaft.

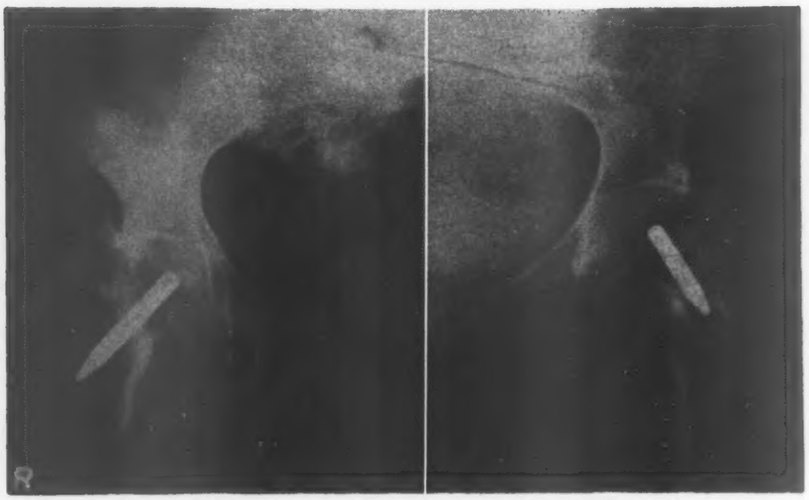
Several years ago, titanium* was described as a metal that could be used in orthopedic surgery [2]. Hip reconstructions using prostheses made of titanium have been performed and observed in patients for several years. The Judet type prosthesis has been used in aged patients with subcapital fractures and has also been used in patients with hypertrophic arthritis. A prosthesis with a stem into the intramedullary canal has been used in patients in whom the neck has been absorbed, following non-union of fractured femoral necks.

In the fifteen cases in which the prostheses have been used, there was primary union of the wound in all. An area of rarefaction about the stem of the prosthesis and varus deformity of the prosthesis have never developed. This certainly suggests that the prosthesis of titanium is well tolerated by the bone. Up to the present time there has been no opportunity to examine any autopsy specimen in humans. The bone apparently becomes tightly adherent to the titanium. This is suggested by previous studies on animals [2,3] as well as the experience in a patient who had a titanium screw inserted to hold an external malleolar fracture. The head of the screw irritated the skin and annoyed the patient. A small incision was made immediately over the screw head under local anesthesia, but a regular screw driver would not budge the screw. The incision had to be enlarged and some bone chipped away to permit grasping the screw head with one of the collet type screw drivers. Even with this type of screw driver the screw was found to be so tight that it was very difficult to remove it. It can, without much doubt, be assumed that the prosthesis does become adherent to and actually part of the femur.

Titanium prostheses have not been used in any cases in which the acetabulum has been reamed. All arthritic hips that were operated on had a sufficient fibrocartilagenous lining of the acetabulum to permit the insertion of a titanium prosthesis without reaming. Animal research is being carried out, at the present time, in an attempt to determine if the prosthesis will become adherent to a reamed acetabulum.

The prosthesis, as used at present, is made of a head and stem screwed together tightly. A variety of head sizes and stems can be made sterile in the operating room and assembled

* Titanium was supplied by the Rem-Cru Titanium, Inc. and Titanium Metals Corporation of America.



1A 1B

FIG. 1. Case 1. A, Judet prosthesis several days after surgery. B, film taken eight months later shows area of demineralization about the stem of the prosthesis.

there with proper sterile tools. When the two are screwed together, a ring on the stem side of the head is then flattened to three flat sections of the stem. This positively holds the two together. None of these fifteen has come apart.

CASE REPORTS

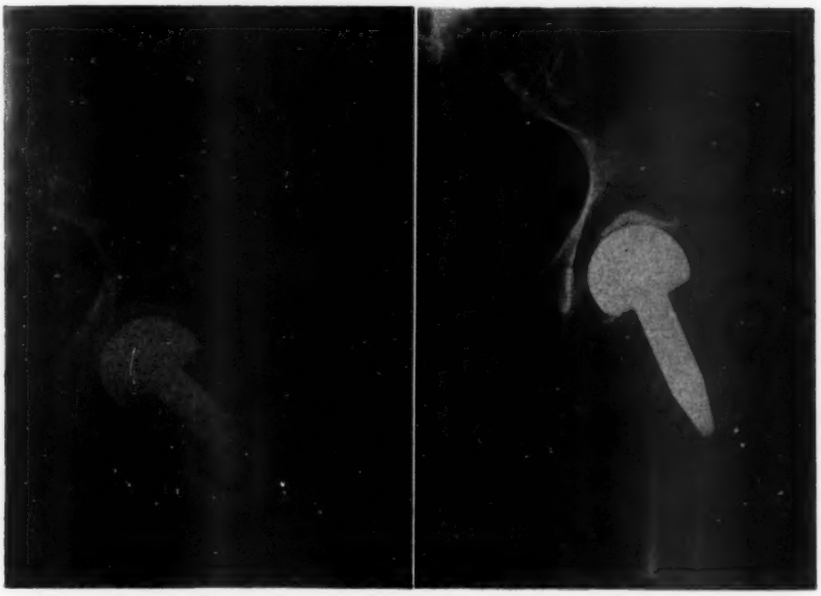
CASE I. S. H., a fifty-five year old woman, who had a cerebral accident and a great deal of difficulty in getting around, used a wheelchair most of the time. She fell and sustained a subcapital fracture. A plastic Judet type of prosthesis was inserted and the patient was up in four weeks. X-ray (Fig. 1A) taken a few days after surgery shows good position of the prosthesis in valgus in June, 1951. X-ray (Fig. 1B) taken on February 2, 1952, showed a typical area of demineralization in spite of the fact that the patient walked very little. This patient demonstrated a typical bone reaction to acrylic prosthesis.

The following are illustrative cases of the use of titanium:

CASE II. H. H., a seventy-four year old woman, sustained a subcapital fracture of the right hip early in March, 1954. A titanium Judet type prosthesis was inserted. (Fig. 2A.) The patient was ambulated in four weeks and got along well. Figure 2B shows the prosthesis with no reaction about the stem in June, 1954. One year later it was learned that the patient was getting along well. No further films were taken. On the films (Fig. 2B) it was apparent that the neck was perhaps a bit too short for perfect abductor muscle function. There was no reaction about the stem and it has not changed position.

CASE III. I. R., an eighty year old man, fell and sustained a subcapital fracture. A Judet type prosthesis with extended skirt to lengthen the neck was inserted. This patient was up at the end of three and one-half weeks, and he walked out of the hospital at the end of one month using one crutch. Within another month he no longer used the crutch, and lived in a nursing home. The patient was seen walking with a very slight limp and no support five months later. Another film could never be obtained but it was quite apparent from his gait that the replacement prosthesis was functioning satisfactorily. (Fig. 3.) The patient died seven months after surgery from a coronary occlusion, but this was not learned until two months after death and no autopsy was performed.

CASE IV. K. K., a seventy-one year old woman, was seen with an ununited fracture of the neck of the femur with most of the screws holding the Jewett nail broken. (Fig. 4A.) The Jewett nail was removed and an Eicer type prosthesis of titanium was inserted. (Fig. 4B.) All of the screw fragments could not be re-



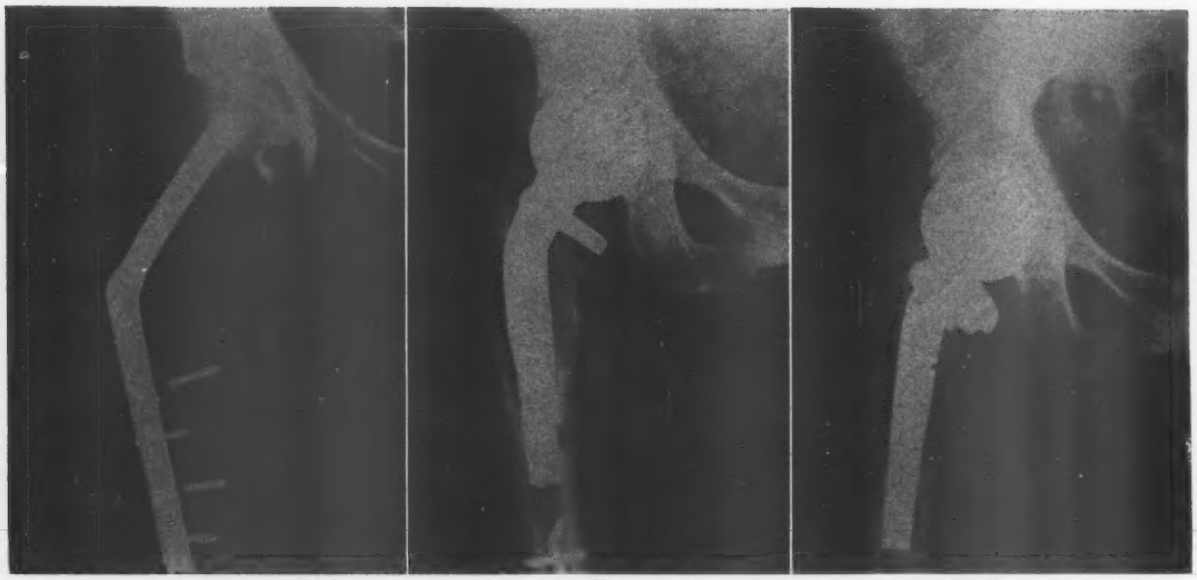
2A 2B

FIG. 2. Case II. A, film taken several days after titanium prosthesis was inserted for subcapital fracture. B, film shows no reaction about the titanium prosthesis three months later.

moved, and were left in the bone below the area of insertion of the prosthesis. A film (Fig. 4C) taken ten months later showed the prosthesis in good position with no reaction about the stem. Motion ten months later was: Flexion to 70 degrees, 180 degrees extension, 30 degrees external rotation, 20 degrees internal rotation and 30 degrees abduction. In spite of this excellent range of passive motion, she complained of pain in the hip and said that she could barely get around. It was believed that emotional factors due to family problems were the real cause of pain, rather than the reconstruction.

CASE V. Mrs. A. M. sustained a fracture of the neck of the femur at the age of sixty-four. Non-union resulted and a McMurray osteotomy had been performed and held with a side plate. (Fig. 5A.) The patient continued to have a great deal of pain and had to walk with two crutches and no weight bearing on the side operated upon. In the middle of December, 1956 a prosthesis of titanium with a stem was inserted. (Fig. 5B.) Some pelvitrochanteric length was restored. Film taken on April 1, 1957, (Fig. 5C) showed the prosthesis with no reaction about the stem. The patient had flexion to 70 degrees, 45 degrees abduction, 15 degrees external rotation and 20 degrees internal rotation. She was able to walk without any support but still preferred a cane in the house and a single crutch outside. Trendelenberg test taken on April 1, 1957, demonstrated normal stability.

FIG. 3. Case III. Film shows the use of an extended type skirt to lengthen a short neck.



4A 4B 4C

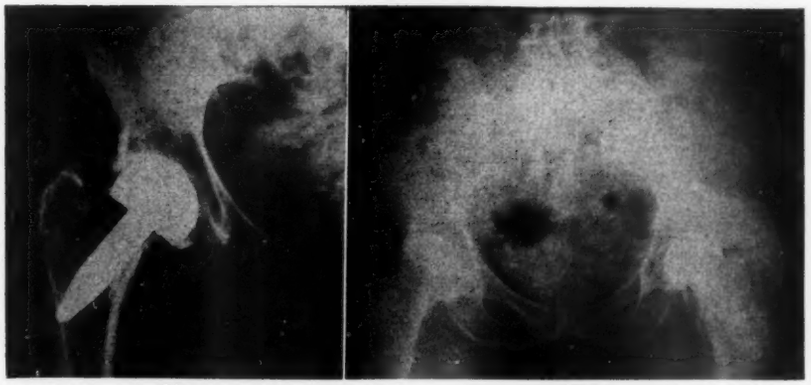
FIG. 4. Case IV. A, fractured neck of the femur with non-union and screws broken. B, Eicer titanium prosthesis inserted May, 1956. C, film taken in February, 1957 shows no reaction about the stem of the titanium prosthesis.

5A 5B 5C

FIG. 5. Case V. A, shows fractured hip for which a McMurray osteotomy was performed. Patient complained of pain. B, film shows stem type titanium prosthesis inserted. C, film taken five months later shows no reaction about the stem of the titanium prosthesis.

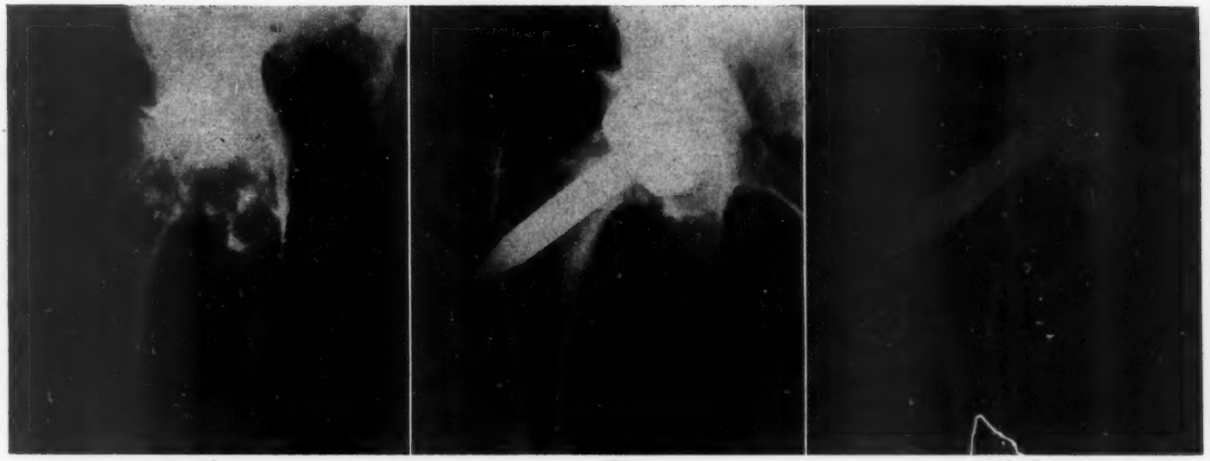
CASE VI. E. N., an eighty-two year old woman, fell and sustained a subcapital fracture of the right hip. A Judet type prosthesis was inserted and even two weeks later, March 27, 1952, it was noted that there was a slight reaction in the region of the outer side of the shaft. (Fig. 6A.) A film, (Fig. 6B), taken November 17, 1953, showed a marked calcification and new bone formation in the region of the outer side of the shaft of the femur and in the gluteus muscles. In spite of this marked reaction, the patient was able to walk without pain but she had no rotation or abduction. There was 80 degrees of flexion and no reaction in the area of the bone traversed by the stem of the prosthesis.

CASE VII. C. H., a sixty year old man, sustained an injury to his left hip following a fall eight years prior to the time he was first seen. Pain in the hip had become progressively worse during these eight years and finally was so bad that he could barely get along. (Fig. 7A.) A titanium Judet type prosthesis was inserted. It was believed that a prosthesis without a skirt could be used. (Fig. 7B.) He was slow in recov-



6A 6B

FIG. 6. Case VI. A, titanium Judet type prosthesis showing periosteal reaction at point of stem two weeks after surgery. B, shows marked periosteal and bony proliferation twenty months later.



7A 7B 7C

FIG. 7. Case VII. A, film showing marked osteoarthritis following injury. B, titanium Judet type prosthesis inserted. C, film twenty-three months later shows no reaction about the titanium stem.

ering. When seen twenty-four months after surgery he said that he was able to walk without the use of any support although he preferred a cane. He had to take aspirin once or twice a week because of slight pain. The hip could be flexed to 70 degrees, adducted 25 degrees, abducted 25 degrees, internally rotated to 40 degrees and externally rotated to 30 degrees. He had 10 degrees of hyperextension. Films taken two years after surgery reveal the prosthesis to be in about the same position as it had been originally with no reaction about the stem. (Fig. 7C.)

TYPE OF PROSTHESIS

From the observation of such cases in which reconstruction arthroplasty had been performed, it became evident that restoration of near normal neck length is important. In patients with hypertrophic arthritis sufficient neck length can be salvaged to permit the use of the original type of Judet prosthesis. Patients with subcapital fractures need extra length. This can best be solved by use of prosthesis demonstrated in Figure 3 or Figure 7B. When the neck is absorbed, a stem type is indicated. (Fig. 5B.)

SUMMARY

Seven cases have been presented in which reconstruction hip arthroplasty has been performed. In the first case a plastic Judet type prosthesis was used. In the other six, prostheses made of titanium were used.

Altogether thirteen patients had been operated upon using prostheses made completely

of titanium. Two patients were operated upon who had titanium Judet stems with nylon heads. The nylon head has not been used since it was learned that nylon did not behave well in the tissues. In none of the fifteen patients has there been any absorption about the stem and the stem has always remained in the same degree of valgus as originally placed.

CONCLUSION

A review of this small group of patients would seem to indicate that titanium is a metal worthy of consideration as a prosthesis in selected cases in which reconstruction arthroplasty is considered. Patients who have had this type of prosthesis have not complained of any sense of giving way and, although other complications have arisen, it appears that some of the complications previously noted have been eliminated.

REFERENCES

1. LAMPERT, C. N. Committee. Symposium on femoral-head replacement prostheses. *J. Bone & Joint Surg.*, 34-A, 407–420, 1956.
2. LEVENTHAL, G. S. Titanium, a metal for surgery. *J. Bone & Joint Surg.*, 33-A, 473–474, 1951.
3. WAKAMATSU, W. Fundamental studies on the use of titanium in orthopaedic surgery. Proceedings Japanese Society of Orthopaedic Surgery. *J. Bone & Joint Surg.*, 37-A, 1294, 1955.

Prosthetic Replacement of the Mid-shaft of the Radius of the Dog

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REPLACEMENT of segments of living tissue presents one of the most interesting problems in modern surgery since it is always undertaken with the knowledge that there will be no perfect substitute for the living structure and the better the prosthesis, the longer it will take to discover its failings. The prosthesis described in this paper does not completely satisfy the dog's need for a radius of normal continuity and function, however, it does not appear to cause unfavorable tissue reactions. It was placed in such a way as to allow a callus of bone to form about it.

In order to replace a mid-shaft segment of weight supporting bone, it was reasoned that the distal and proximal segments must be kept in normal alignment and held at their original distance apart. This device had to be firmly fixed to both distal and proximal bone ends [*1*]. It was designed with an outside diameter less than that of the bone. The points of the prosthesis were grooved to prevent rotation. These points could be placed in the medullary canal beneath the bone cortex and the periosteum. It was hoped that by not covering the periosteum, a callus would form at each end which would firmly anchor the prosthesis.

Titanium metal, made available recently, was used to construct the prosthesis. Titanium was recommended as being biologically neutral, and in this experiment no unfavorable tissue reaction was seen. The weight and rigidity of this metal is midway between stainless steel and aluminum alloys. This metal is a poor conductor of electricity and heat. It is harder than copper or aluminum alloys, but not as hard as stainless steel. (Table 1) [*2,3*].

The prosthesis (Fig. 1) is a titanium rod slightly smaller in diameter than the bone cortex it is to replace. The ends are hollow ground points to resist rotation on the long axis of the bone. The devices which were four inches long were machined to a smaller diameter in the mid-shaft area and holes were drilled in the wider ends to reduce weight. This machining reduced the weight so that the device was only 5 to 10 gm. heavier than the bone it replaced. To attach the prosthesis a canal was drilled, the length of the center of the shaft, to form a channel just large enough to accommodate a titanium intramedullary pin. To install the device the intramedullary pin was driven through the distal segment of the radius, through the prosthesis and into the proximal segment. (Fig. 2A.)

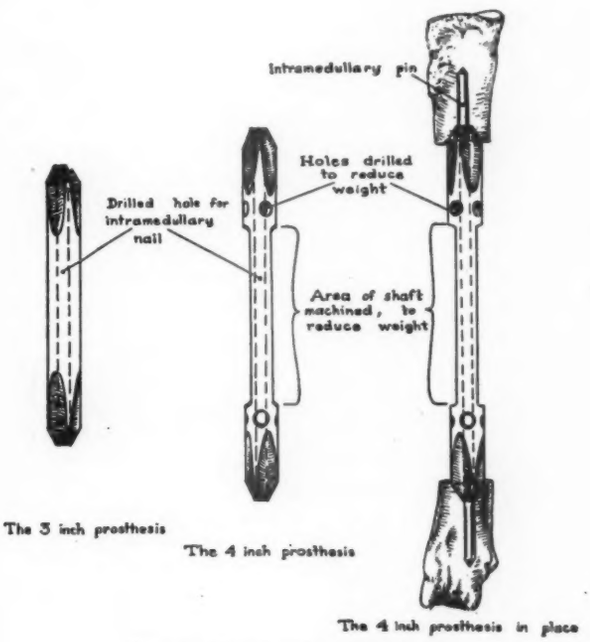
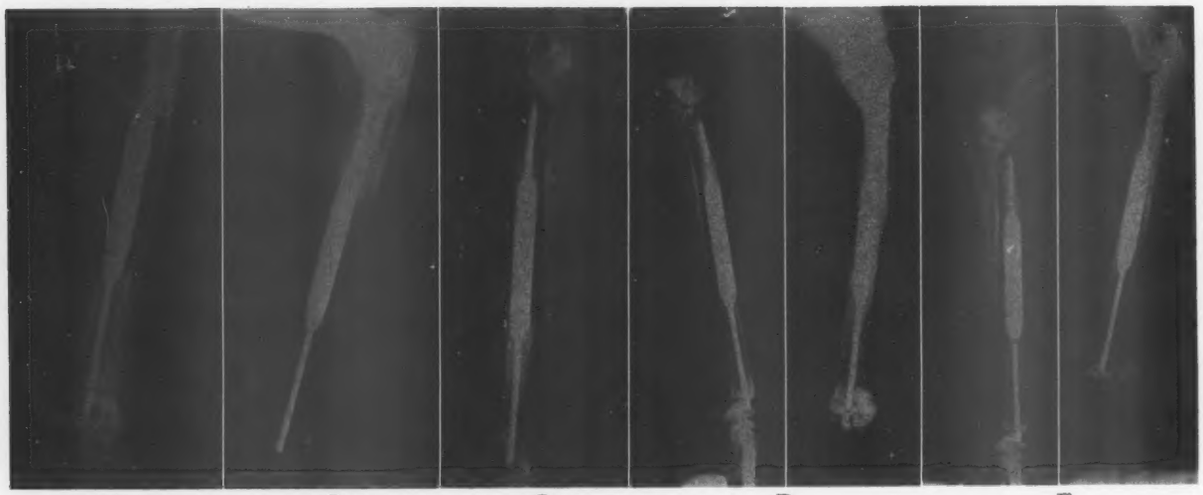

Intramedullary pin
Holes drilled to reduce weight
Drilled hole for intramedullary nail
Area of shaft machined, to reduce weight
The 3 inch prosthesis
The 4 inch prosthesis
The 4 inch prosthesis in place

FIG. 1. The titanium prosthesis.



2A 2B 2C 2D 2E

FIG. 2. The 3 inch prosthesis used in dog No. 291. A, immediately postoperatively; B, eight weeks postoperatively; C, eleven weeks postoperatively; D, eleven months postoperatively; E, twenty-seven months postoperatively.

Eight normal dogs weighing 30 to 40 pounds were used for this study. Each operation was conducted under strict asepsis. An incision was made on the medial side of the forearm. The mid-shaft of the radius was isolated and the muscle attachments removed. A 2¾ inch segment of bone was removed before the 3 inch prosthesis was placed. The bone segment was shorter than the prosthesis so that the medullary canal of both distal and proximal segments might be widened by reaming to receive the point of the metal segment. A titanium intramedullary pin was driven from the proximal end of the distal segment through the intramedullary canal and to the outside through the carpal joint. Next, the prosthetic shaft was put in place and the intramedullary pin driven through the prosthesis into the proximal segment of the radius. A coaptation splint was applied to the arm for two weeks, and the dog

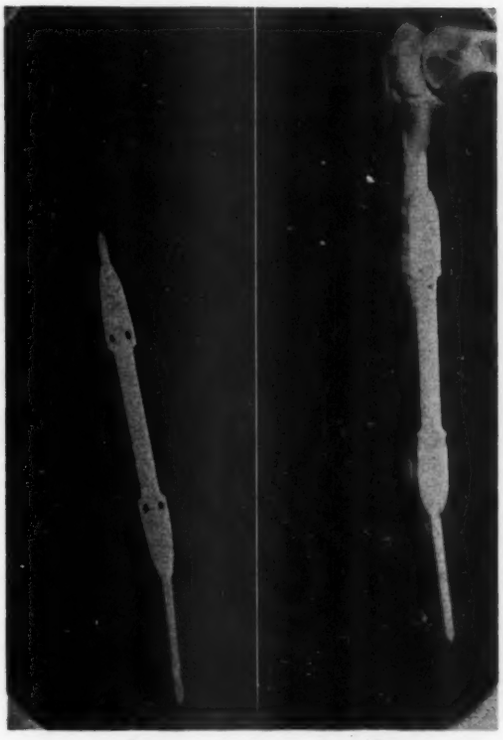
TABLE I

COMPARISON OF THE PHYSICAL PROPERTIES OF STAINLESS STEEL (ALLOY 316), VITALLIUM (STELLITE 21) AND COMMERCIALLY PURE TITANIUM (TI 75A)

Metals	Density (lb./sq. inch)	Composition (%)	Tensile Strength (1,000 PSI)	Yield Strength (1,000 PSI)	PCT. Elongation in 2 Inches	Machining Properties	Heat Conductivity	Electric Conductivity
Stainless steel (alloy 316)	0.288	C 0.10 maximum Cr 16.0 to 18.0 Ni 10.0 to 14.0 Mo 2.0 to 3.0 Fe remainder	100 to 150	50 to 125	50 to 15	Fair Tough	Good	Good
Vitallium (stellite 21)	0.297	Co 62.20 Cr 27.42 Mo 5.53 Ni 2.84 Fe 0.70 Mn 0.66 Si 0.53 C 0.22	101	82.3	8.2	Difficult	Poor	
Titanium (ti 75A)	0.163	Ti 99.4 Fe 0.20 maximum C 0.10 maximum W 0.02 maximum Si 0.02–0.04 N_2 0.08 maximum H_2 0.015 maximum	80 to 105	70 to 95	15.0	Fair; has high friction	Very poor	Poor

3A 3B

FIG. 3. The short prosthesis used in dog No. 291. A, immediately postoperatively; B, three months after fracture of leg.



4A 4B

FIG. 4. Dog No. 1862 ten months postoperatively.

was given penicillin (300,000 units) and streptomycin (.5 gm.) intramuscularly for seven days.

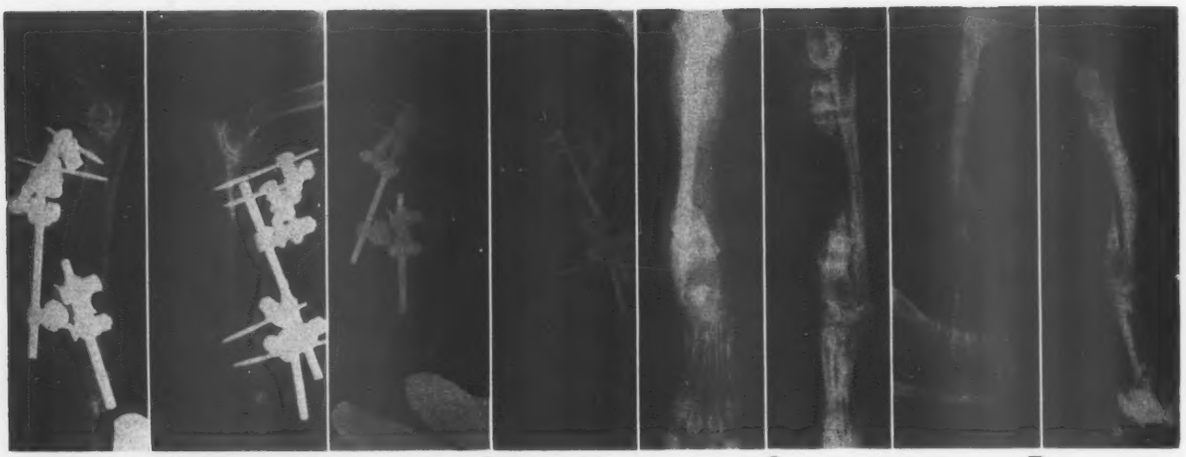
The first day of use of the foreleg for body support varied from one and one half months to five months postoperatively. Four of the five dogs that received the 3 inch prosthesis attained normal locomotion in five to seven months; two of three dogs with the 4 inch prosthesis walked normally in seven to ten months. In six dogs flexion of the carpus was impaired by the intramedullary pin protruding into the radial carpal bone. (Figs. 2A and 4.) In some of these animals, this was due to or increased by shortening of the bone as it healed. It did not interfere with locomotion but reduced flexion of the carpus to about 60 degrees. All dogs are able to use their legs for other than body support. A tabulation of the dogs and results of their operations to date is shown in Table II.

Dog 291 was typical of the animals in which the 3 inch prosthesis was used. Figure 2A is a radiograph showing the prosthesis in place immediately postoperatively. Figure 2B was

TABLE II
RESULTS OF OPERATIONS

Dog (No., Name)	Age at Time of Operation (mo.) and Sex	Prosthesis, Length in Inches	Months Postoperatively	Weight Bearing at Present	First Postoperative Day of Weight Bearing
291	24, F	3	27	Normal	70
Clancy	7, M	3	28	Normal	160
Luther	7, M	3	24	Normal	150
Lulu	7, F	3	11	Normal	160
3621*	48, F	3	23	Nearly complete	400
1861	14, F	4	22	Normal	240
1862	24, F	4	21	Normal	210
2812	45, F	4	18	Nearly complete	...
291 (other leg)	33, F	3	18	Normal	55

* Had a wound infection.



5A 5B 5C 5D

FIG. 5. Oscar, one of the controls which received no prosthesis. A, radiograph taken immediately postoperatively; B, five weeks postoperatively; C, twelve weeks postoperatively; D, twenty weeks postoperatively.

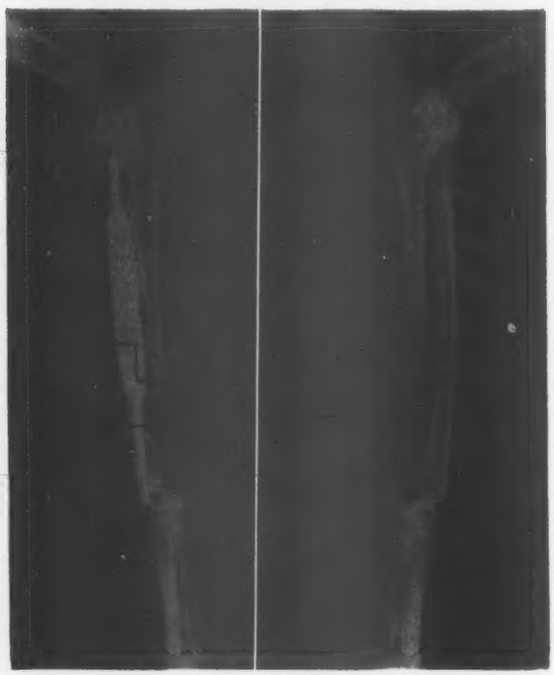


FIG. 6. Site of removal of microscopic sections from Lulu's radius.

taken eight weeks later and shows the bone callus forming at the severed bone ends where the prosthesis is attached. Periodic radiographs revealed that a calcified sheath of callus formed around the metal shaft. (Figs. 2C to E.)

Dogs 1861 and 1862 are exceedingly vigorous animals and at about the ninth month postoperatively, broke the intramedullary pin at the distal junction with the prosthesis. Following this they were lame for about two weeks. The intramedullary pin used in the second prosthesis placed in dog 291 was not long enough to prevent lateral motion (Fig. 3A), therefore when this animal began to bear weight three months after the operation the ulna was fractured. Since the prosthesis remained in place, the arm was placed in a cast until the ulna formed a firm callus. Weight bearing was complete on this limb about three months after the fracture. (Fig. 3B.)

When evidence of bone appeared surrounding the metal shaft, it was suspected that perhaps the periosteum had not been entirely removed. The removed segment had only been examined grossly; later segments were examined histologically. Only in the posterior proximal area of the removed segment, where the radius is attached to the ulna, did any periosteum remain in the body of any of the six animals operated on subsequently. By installing a longer prosthesis, it was thought that long callus formations would be inhibited. These devices were also covered by callus. (Fig. 4.) Calcification of the sheath of callus did not occur much more rapidly at the ends of the sheath than in the middle. It is not certain whether the bony sheath about the metal shaft is the result of growth from the cut bone ends or whether it is due to the osteogenic activity of the loose connective tissue which surrounded the prosthesis.

In order to determine what compensating mechanism would develop if a similar segment of radius was removed and the leg supported, five dogs received the same operative procedure as the dogs that received the prosthesis, except that their legs were immobilized with a Kirschner splint. (Fig. 5A.) The legs of two of these

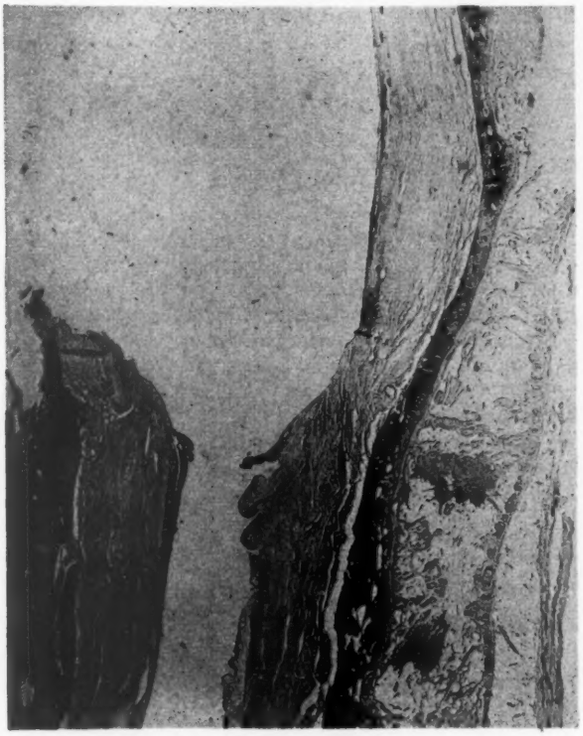


Fig. 7. Histologic section of Lulu's radius at the point of junction with the prosthesis. Original magnification × 100.

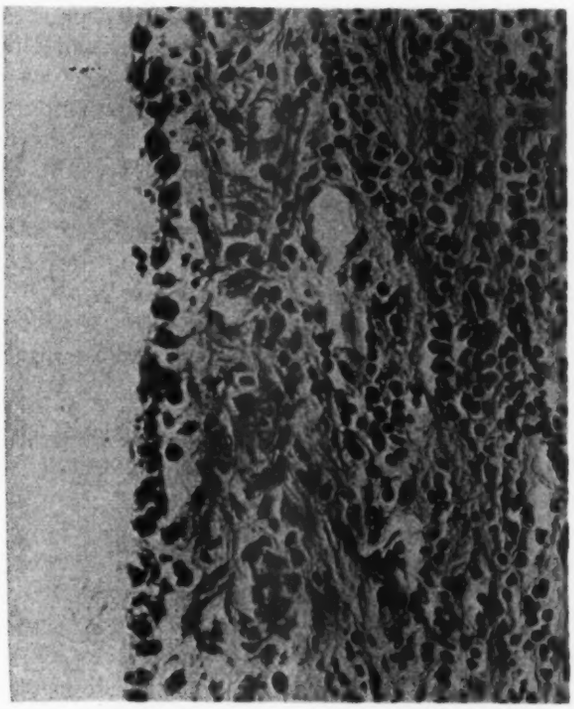


FIG. 8. Histologic section of Lulu's radius showing synovial-like lining that surrounded the prosthesis. Original magnification × 285.

dogs are severely bowed out, but they can use them for weight bearing. It was necessary to keep splints on the operated legs for about ninety days before the dog would use the leg. In two of these control dogs an intramedullary pin was passed down the medullary canal of the ulna. This reduced bowing of the leg. Compensation for this loss of the mid-shaft of the radius consisted of thickening of the ulna, callus formation at the cut ends of the radius and an involucrum that formed along the dorsal medial side of the ulna. (Fig. 5B to D.)

The dog named Lulu was sacrificed eleven months postoperatively. Autopsy revealed a bony callus completely surrounding the prosthesis. (Fig. 6.) The involucrum was heaviest on the anterior side, thinnest on the ulnar side. This distribution of bone thickness is similar to that of the normal radius of the dog. Grossly, the callus appeared calcified except on the dorsomedial side. There was a shiny membranous lining within the sheath of callus. Histologic sections taken from the junction of the callus and the normal bone (Fig. 6), demonstrated that the lining around the prosthesis was similar to chronically inflamed synovial membrane. (Figs. 7 and 8.) The sheath of callus contained Haversian canals and closely resembled normal bone. The source of this bone was not determined, but it is suggested that the origin was from the undifferentiated cells of connective tissue about the removed radial segment. (Fig. 2B.)

CONCLUSIONS

1. This type of prosthesis was satisfactory for the replacement of the mid-shaft of the radius of the dog although use of the limb for weight bearing was delayed several months.
2. Regrowth of long segments of bone callus occurred in young dogs.
3. The source of new bone growth covering the prosthesis is not completely explained by the radiographs or the histologic section.
4. Restoration of the bone continuity was accomplished when this prosthesis was used. It must now be used in bones that are not as well splinted naturally, as is the radius.

SUMMARY

In a study of the effect of replacing one-half of the shaft of a partial non-weight bearing bone in the dog, the radius was selected because

it is splinted by the ulna which participates considerably in supporting the weight of the front quarter of the body. A prosthesis was designed which would keep the bone segments in line, hold them apart in their normal position and add as little as possible to the weight of the bone. It was observed that a sheath of callus formed around the prosthesis restoring the continuity of the bone in about six to twelve months.

Titanium was used to evaluate the quality of this recently available metal in making bone prosthesis.

Acknowledgment: The author wishes to express his gratitude to Dr. Leon Sokoloff of the National Institutes of Arthritis and Metabolic Diseases for evaluating the pathologic specimens.

REFERENCES

1. Fitts, W. T., Brooke, R., Jacques, J., Grippe, W. and Sheldon, W. Replacement of bone defects in dogs with circumferential autographs and homographs fixed with an intramedullary nail. *Ann. Surg.*, 142: 351–360, 1955.
2. Taylor, L. Editor. Metals Handbook, pp. 553–581. Cleveland, 1948. American Society for Metals.
3. Handbook on Titanium Metal, 7th ed. New York, 1953. Titanium Metals Corporation of America.
4. Weinmann, J. P. and Sicher, H. Bone and Bones, 2nd ed., pp. 309–337. St. Louis, 1955. C. V. Mosby.

Fractures of the Shaft of the Tibia in Adults Treated with Multiple Wire Fixation

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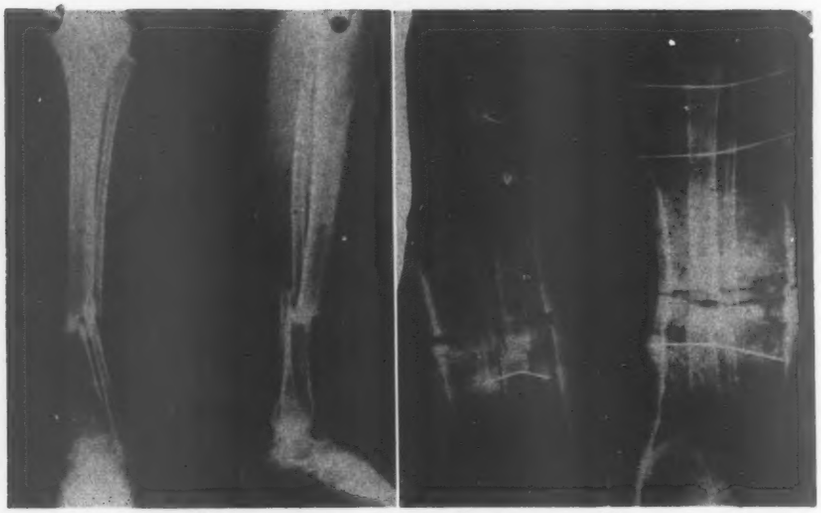
IN uncomplicated fractures of the tibia that are seen early, satisfactory reduction is not difficult to attain; the real problem is the maintenance of adequate immobilization, especially of unstable fractures, for which many procedures have been proposed and various apparatuses devised. This study was undertaken to determine the efficiency of multiple Kirschner wire and plaster fixation in the treatment of fractures of the shaft of the tibia in adults; fractures in children do not present as many difficulties as those in adults. It is also the purpose of this study to determine the types of fracture in which this method of treatment, if found adequate, is indicated. Although this method of treatment has been in use for over twenty-five years, it was chosen in this study because of its simplicity of application and the easy availability of material. With proper aseptic precaution very little risk is involved. The re-evaluation of this method of treatment is intended to provide a simple and adequate method of immobilization for those general surgeons who are called upon to handle cases of this nature.

The ideal method of treatment of fractures is accurate reduction followed with uninterrupted immobilization. Speed [*17*] stated that the use of force supplied by traction and countertraction followed with fixation is as old as the treatment of fractures itself. However, Orr [*13*] wrote that although traction is the most important factor in the treatment of fractures, it is the least understood and the least efficiently employed, so that after traction is released following primary reduction there is a tendency toward deviation or angulation at the point of fracture.

The treatment of fractures of the shaft of the tibia in adults is difficult because of the anatomic and physiologic characteristics of the bone. The Subcommittee on Orthopedic Surgery of the National Research Council [*19*] stated that fractures of the tibia heal very slowly and that if union is secured in from four to twelve months, the results can be considered satisfactory. The shaft of the tibia is composed mostly of dense cortical bone devoid of muscle attachment at its distal end and along the entire anteromedial surface. There is only one major nutrient artery that enters the bone through the nutrient foramen which is situated posteriorly at the junction of the proximal and middle third. Smaller arteries enter at both ends while the shaft derives part of its blood supply from the periosteum and muscle attachment. If the nutrient artery is cut following a fracture just distal to the nutrient foramen, the proximal end of the distal fragment loses a major portion of its blood supply.

The superficial location of the tibia predisposes it to injuries with a high percentage of open fractures. Senger and Norman [*15*] reported an incidence of 23.1 per cent open fractures of 1,000 fractures of the leg. Of the original ninety-two fractured tibias in this study, forty-two or 45.6 per cent were open fractures. Following a direct injury the soft tissue is usually severely damaged, being caught between the hard bone and the inflicting force. An indirect injury produces either a spiral or an oblique fracture usually at the junction of the middle and the distal third of the bone. In the majority of cases the fracture line is directed downward and medially, suggesting that the momentum of the force carried the body forward and medially, producing an internal rotation of the proximal fragment while the foot was fixed on the ground. Not



1A 1B

FIG. 1. Case 1. A, closed fracture of the distal third of both the right tibia and fibula treated with continuous skeletal traction for one week followed with plaster cast immobilization. After five months there was no clinical evidence of union and radiograph shows lateral deviation of the distal fragments by about 15 degrees in spite of a previous correction. B, multiple Kirschner wire and plaster fixation was applied and the alignment was corrected by wedging the cast.

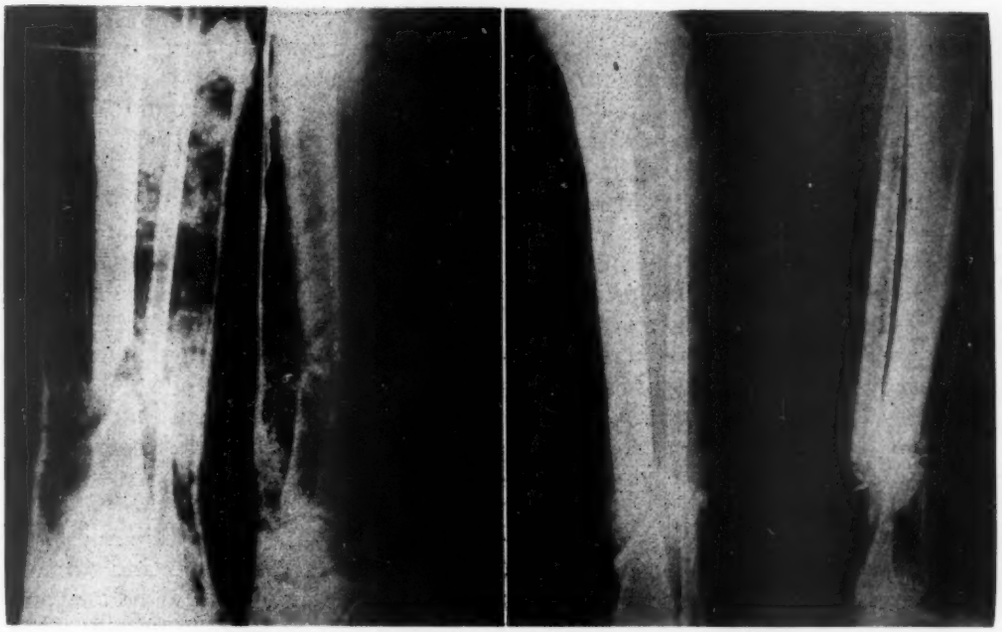
infrequently the overriding of the fragments causes the sharp edges of the bone to penetrate the skin.

In fractures of the distal third of both the tibia and fibula at about the same level, the distal fragments tend to rotate externally and to deviate laterally. This may be due to the fact that most of the extrinsic muscles of the foot originate from the lateral side of the leg; contraction of these muscles will pull the foot and the distal fragments laterally.

CASE 1. A seventy-nine year old woman was admitted on June 11, 1950, with a closed fracture at the distal third of the right tibia and fibula with a wedge-shaped fragment at the lateral side of the tibia and a closed fracture of the left tibia alone at about the same level. (Fig. 1A.) She was treated initially with continuous skeletal traction with both legs on Braun-Böhler frames. After one week a plaster cast was applied from the toes to the upper thigh with both knees flexed to about 135 degrees. Unfortunately, traction was discontinued and the wires were pulled out. A radiograph taken on the fourth week showed about 20 degree lateral deviation of the distal fragments of the right side; the left leg showed good position and alignment. A new cast was applied and the angulation was corrected by wedging the cast. Five months later the right leg showed no clinical evidence of union. A lateral deviation of 15 degrees had recurred. The left leg healed satisfactorily. Multiple Kirschner wire and plaster fixation was applied to the right leg and the angulation was corrected by wedging the cast. (Fig. 1B.) Five weeks later the wires were pulled out, and after another five weeks of immobilization union was obtained in satisfactory alignment.

In unstable fractures of the distal third of both the tibia and fibula, Watson-Jones [24] advises continuous skeletal traction with 5 to 10 pounds for a few weeks in conjunction with plaster cast immobilization. The same effect may be attained with the use of multiple Kirschner wires, incorporating them in the plaster cast; this method will counteract the tendency of the distal fragments to deviate laterally.

CASE 11. A fifty-one year old man was admitted with an open comminuted fracture of the distal third of the right tibia and fibula, and a closed comminuted fracture of the distal third of the left tibia alone. Débridement and primary closure were performed on the right leg, and multiple Kirschner wire and plaster



2A 2B

FIG. 2. Case 11. A, an open fracture of the distal third of both the right tibia and fibula treated with débridement and primary closure followed with multiple Kirschner wire and plaster fixation. There was very little bone contact due to loss of bone substance. B, eight weeks later the wires were pulled out and radiograph shows abundant callus with no change of position or alignment.

fixation was applied on both legs with the cast extending from the toes to just below the knees. (Fig. 2A.) In spite of a bone defect of about ¼ inch on the right tibia, there was clinical union at the end of eight weeks and a radiograph (Fig. 2B) showed abundant callus. Perkins [*14*] believes that by encouraging the activity of the muscles overlying the fracture, repair could be hastened.

In the treatment of fractures of the tibia, reduction should be done as early as possible before soft tissue contracture sets in. Careful evaluation of the patients' condition should be made first, since all patients with severe fracture are potentially or actually in shock and no attempt at reduction should be made until the situation has been corrected. Of the original eighty patients, six or 7.5 per cent were in shock or went into early shock.

MATERIALS AND METHODS

Originally there were eighty adult patients with ninety-two fractured tibias. Of these, four patients died of associated trauma or concomitant disease, two required amputation, two had infection at the fracture site lasting for over four weeks, one had loss of bone substance, one had extensive loss of soft tissue and four had no follow-up, leaving sixty-six patients with seventy-eight fractured tibias. The management of any particular case depended more on the preference of the attending surgeon than on any systematic selection of cases.

TABLE 1
METHODS OF TREATMENT AND DISTRIBUTION OF CASES

	Plaster Cast Fixation	Two or More Wires and Plaster	Internal Fixation	Skeletal Traction
Closed fractures...	20*	18	8	..
Open fractures....	13	16	..	3

* In 2 cases multiple Kirschner wire and plaster fixation was required to correct persistent angulation after the fifth and the sixth month, respectively.

Similar cases were treated differently. Sometimes the method of treatment had to be changed whenever such was indicated. There were forty-six closed fractures, while thirty-two were open. Table 1 shows the methods of treatment and the distribution of cases.

For closed fractures of the shaft of the tibia which can be reduced by manipulation and

position maintained without the use of skeletal traction or fixation, plaster cast from the toes to the upper thigh may suffice. The plaster cast may be applied as a single unit or in segments.

The use of multiple Kirschner wire and plaster fixation for fractures of the shaft of the tibia was studied and the following procedure was used, with minor changes whenever indicated. Kirschner wires with a diameter of 0.062 inch were found to be satisfactory. One wire is inserted through the anterior tibial tubercle; the second one is inserted slightly more distal, and the third one through the os calcis. The second wire is inserted at a slightly different horizontal plane in order to prevent lateral movement of the proximal fragment. After the wires have been inserted, the fragments are reduced and the plaster cast is applied, incorporating the wires in it. Sometimes it is more convenient to apply the plaster cast in two segments as described by West [25]. The proximal segment is from just above the fracture level to the upper thigh, while the distal segment is from just below the fracture level to the toes. After the plaster has set, the fracture is reduced and the cast is completed. Sufficient padding is applied around the wires and precaution is taken to avoid the formation of pressure sores. If the fracture is at the distal third, the plaster cast may be left below the knee as in Case 11. For fractures of the middle third, the cast is extended to the upper thigh with the knee at about 10 to 15 degrees short of full extension. In fractures of the proximal third, when only one wire can be inserted through the proximal fragment, the knee is immobilized at about 135 degrees' flexion. The wire ends are cut off, leaving 1 inch on each side so as to be held firmly in the cast. In applying the plaster cast, the wire ends should be well covered with plaster in order to prevent migration of the wires.

Open fractures are surgical emergencies and should be treated as soon as the condition of the patient will permit. The immediate objective in the management of all open fractures is to prevent infection. Whenever possible, all open fractures were closed after thorough débridement and irrigation of the wound with normal salt solution. The subsequent management was similar to that of a closed fracture but supplemented by antibiotics, tetanus antitoxin and anti-gas gangrene serum. However, in no instance was primary internal skeletal fixation used in an open fracture. When foreign bodies were present and could not be removed or when there was extensive loss of soft tissue that could not be repaired, the wound was packed open with vaseline gauze.

RESULTS

Of the original forty-two open fractures in this study, thirty-seven were closed primarily. Three patients were lost within forty-eight hours. Twenty-five fractures healed by primary intention. Five had mild infection, and four had severe infection which required amputation in two instances due to vascular insufficiency, while gas infection developed in one patient who died later. Five wounds were left open because in two there was extensive loss of soft tissues while three were due to shrapnel.

Following débridement and primary closure, only four or 11.8 per cent had severe infection while five or 14.7 per cent had mild infection. Mild infection is meant in this report as the presence of discharge from the wound lasting for not over four weeks and which required no other form of treatment besides the administration of antibiotics. Although the use of antibiotics in the foregoing cases had made the infection so mild that no further treatment was required, the use of the drugs alone cannot be a substitute for good surgery; and early débridement with excision of all devitalized tissues is very important. Most surgeons agree that the majority of open fractures seen within eight hours may be safely closed. But a grossly contaminated wound is better left open while a relatively clean wound seen after twelve hours may still be safely closed.

The results obtained in thirty-three cases with plaster cast immobilization were compared with those obtained in thirty-four cases treated with multiple Kirschner wire and plaster fixation. (Table 11.) No attempt is being made to evaluate the results obtained from the use of internal skeletal fixation or skeletal traction because the number is very small. Of the thirty-three cases with plaster cast immobilization, twenty-seven fractures or 82.0 per cent healed within six months, five or 15 per cent had delayed union and one had non-union. Two fractures with delayed union required multiple Kirschner wire and plaster fixation to correct persistent angulation. In five instances, although healing took place within six months, there was malunion due to a change

TABLE II

END RESULTS ON SEVENTY-EIGHT FRACTURED TIBIAS

	Manipulation and Cast		Multiple Wire and Plaster Fixation		Internal Fixation		Skeletal Traction	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed
Union in 6 mo.	9	18	16	18	..	6	3	..
Delayed union.	3	2*	..	..	..	1	..	..
Non-union.	1	..	..	..	..	1	..	..

* Multiple Kirschner wire and plaster fixation was applied after the fifth and sixth month, respectively, to correct persistent angulation.

of position of the fragments. On the other hand, all the thirty-four fractures treated with multiple wire and plaster fixation healed within six months with no appreciable change of position even of unstable fractures.

Of the original forty cases treated with multiple wire and plaster fixation, four were excluded because infection was present in two cases, one had loss of bone substance and another had extensive loss of soft tissue. The other two cases which required multiple wire and plaster fixation to correct persistent angulation were included with those treated with plaster immobilization.

REMARKS

The biomechanics of fracture healing shows that perfect apposition produces earlier repair and that separation results in delayed healing. Perfect apposition is often difficult to obtain, especially in comminuted fractures, so that the surgeon may resort to open reduction and to applying some form of internal skeletal fixation. On the other hand, Urist and co-workers [22] believe that open reduction and internal fixation may have adverse effects on bone repair in that it adds further trauma to the original injury so that the operation may simply overload the capacity of the tibia for repair. With adequate immobilization union may be expected even if satisfactory apposition has not been obtained and even if the amount of contact is less than one-third of the cross section of the bone.

CASE III. A sixty-nine year old woman was admitted with an open fracture of the mid-shaft of both the right tibia and fibula. Débridement and primary closure of the wound was done, and multiple wire and plaster fixation was applied. A radiograph (Fig. 3A) showed very little contact due to lateral displacement of the distal fragment of the tibia, which made reduction unstable. However, alignment was satisfactory and it was decided to accept the result with the idea of performing an open reduction later if it became necessary. Six weeks later the cast was changed and the wires were pulled out; the fracture was found to be firm and stable. A radiograph (Fig. 3B) taken after further immobilization in plaster for another ten weeks showed almost solid union with no change of position or alignment.

This case shows that in comminuted fracture of the tibia, even if the amount of contact is very little, union may be expected if adequate immobilization is maintained. Without the use of multiple wire and plaster fixation, it is very doubtful whether the original position could have been maintained.

CASE IV. A sixteen year old boy was first seen two weeks after he had sustained a closed fracture of the middle third of both the left tibia and fibula. Although alignment was satisfactory, there was very little contact of the bone ends and attempts to improve the position of the fragments failed. (Fig. 4A.) Multiple wire and plaster fixation was applied for ten weeks followed with plaster cast immobilization for another six weeks. At the end of sixteen weeks there was clinical evidence of union and a radiograph (Fig. 4B) showed plenty of callus. In spite of poor apposition with very little contact of the bone ends, union was obtained with no appreciable change of position or alignment.

3A 3B

FIG. 3. Case III. A, an open comminuted fracture of the mid-shaft of the tibia and upper fibula treated with débridement and primary closure. Multiple Kirschner wire and plaster fixation was applied. Post-reduction film shows very little bone contact. B, three months later there was good evidence of union.

4A 4B

FIG. 4. Case IV. A, closed fracture of the middle third of both the left tibia and fibula treated with closed reduction and multiple Kirschner wire and plaster fixation. There was very little contact of the bone ends. B, after sixteen weeks there was clinical evidence of union and radiograph shows a great deal of callus.

It has been shown in the foregoing that multiple Kirschner wire and plaster fixation provides adequate immobilization and prevents any change of position even of unstable fractures. However, when satisfactory reduction cannot be obtained by closed method, surgery may be resorted to with some form of internal or external skeletal fixation. McLaughlin and Ryder [*10*] advocate early open reduction and skeletal fixation with plates and screws as soon as the condition of the patient will permit. The absolute indications are gross interposition of soft tissue, transfixion of calf fascia and multiple fractures at different levels unless properly reduced. For oblique and spiral fractures, open reduction and screw fixation has been found to give satisfactory results. Arzimanoglou and Skiadaressis [*1*] recorded the results of an experimental study on the efficiency of screws applied at different angles. They found that screws inserted at right angle to the cortex allow more impaction with less displacement of

the fragments when vertical pressure is applied. However, when the screws are applied at right angle to the fracture line, vertical pressure causes lateral displacement and wide separation of the fragments. For selected fractures of the middle third, either oblique or transverse, intramedullary fixation with the Küntscher nails, the Lottes nails, the V-nails or the Rush pins may be used. Comminuted fractures are not ideal cases. Vom Saal [*23*] used the V-nails in thirty-four fractured tibias and claimed rapid union in all cases. Thomson [*20*] reported good results on the use of Küntscher nails. Fett and Smith [*5*] used primary sliding bone graft with screw fixation in eight cases of fractured tibia, and claimed rapid healing. Any local infection either of the skin or bone and any active foci of infection elsewhere in the body are contraindications.

The use of internal skeletal fixation in open fractures of the tibia is still a point of disagreement. Caldwell [*2*] quoted Hey Groves as saying that plating of an open fracture should be regarded as a surgical crime. However, he also mentioned Foster's review of 304 cases of open fracture from the Sherman Clinic of which 146 fractures which were plated showed less incidence of infection or sinus formation. He thinks that plating should be reserved for less contaminated cases. McMaster [*11*] is of the opinion that internal fixation of open fractures is not advisable. Le Roy Abbott stated, in his discussion of the paper of Cleveland and Winant [*4*], that internal fixation especially with plates should be avoided in open fractures since it is frequently followed with infection. On the other hand, Stimson [*18*] reported good results with early débridement and plating followed with primary closure of the wound. She believes that if the bone ends are rigidly fixed by plate and screws, further damage to the surrounding soft tissue is eliminated and that systemic reaction and drainage drop to a minimum. In this study no internal skeletal fixation was used in open fractures; plaster immobilization or multiple wire and plaster fixation was used instead.

Following débridement, complete skin coverage of the exposed bone is most desirable. In one case in this study the skin defect was so extensive that it was decided to leave the wound open. After a few days a split skin graft was applied. In another instance the patient was in shock so that no further surgery could be performed. Later sequestrectomy was performed and a split skin graft applied. In a third case there was an extensive laceration of the anterior aspect of the left upper leg with a comminuted fracture of the upper tibia. Thorough débridement was done more than ten hours after the time of injury. There was an elliptic skin defect of about 4 inches long by about 2 inches at its widest. Relaxing incisions were made on both sides and the skin flaps were undermined and pulled over the bone and sutured together. At the end of four weeks when the cast was bivalved, the original wound had healed by primary intention. This illustrates the importance of complete skin coverage of exposed bone. It also demonstrates that primary closure can be done safely even after ten hours from the time of injury.

Double fractures of the tibia are more difficult to reduce and require a longer time to heal. When the fracture lines are both distal to the nutrient foramen, the middle fragment loses most of its blood supply and non-union may develop. May [*9*] reported a rare case of double fracture with double non-union. The treatment of double fracture of the tibia is preferably by open reduction and skeletal fixation since satisfactory reduction is difficult to obtain otherwise. If the condition of the patient does not permit surgery, continuous skeletal traction may be tried. In this study there were three cases of double fracture, each treated differently. The first patient had a comminuted middle fragment. Continuous skeletal traction was applied with the leg on a Braun-Böhler frame and union was obtained. The second patient underwent primary open reduction, with a single Rush pin for intramedullary fixation. The leg was immobilized in a plaster cast from the toes to the upper thigh for six weeks. A radiograph taken at the end of nine weeks showed a medial angulation of about 10 degrees at the proximal fracture level. This was probably due to the pull of the thigh muscles attached to the medial aspect of the proximal fragment, there being no corresponding muscle attached to the lateral side, for sometimes the patient complained of severe pain at the knee on weight bearing which was probably due to strain on the lateral collateral ligament as a result of the medial deviation of the proximal fragment. This condition could have been avoided if two Rush pins had been used instead. The third patient had a com-

5A 5B 5C

FIG. 5. Case v. A, an open fracture of the distal third of the left tibia treated with débridement and primary closure followed with multiple Kirschner wire and plaster fixation. The wires were too small and were cut too short to be held firmly in the plaster. B, radiograph taken a week later shows that the wires had migrated. C, the wires were replaced with heavier and longer ones. Radiograph shows the ideal length of the wires.

minuted fracture 3 inches below the knee and an oblique fracture at the mid-shaft. Closed reduction under anesthesia was tried twice and both attempts failed. Open reduction was done followed with multiple wire and plaster fixation.

The success or failure of multiple Kirschner wire and plaster fixation may depend to some extent on the choice of wires and on the manner in which they are incorporated in the cast. Some surgeons prefer to use the spreader attached to keep the wires taut, so as to prevent the wires from bending. However, it is not always necessary to maintain the wires rigid as long as they are properly incorporated in the cast. The skin around the wires should be well protected to prevent the formation of pressure sores. About 1 inch of wire is left on each side and the wire ends should be well covered to prevent migration of the wires.

CASE V. A thirty-six year old woman was admitted with an open fracture of the lower third of the right tibia. Débridement and primary closure was done, and multiple wire and plaster fixation was applied. The wires were too fine and the ends were cut too short to be held firmly in the cast (Fig. 5A), so that after one week the wires had migrated (Fig. 5B). The cast was changed and the wires were replaced with heavier ones, covering the wire ends completely to prevent migration of the wires as shown in Figure 5C.

FIG. 6. Case VI. An open fracture of the left tibia treated with débridement and primary closure followed with multiple Kirschner wire and plaster fixation. Radiograph taken five months later shows that the fracture is healing satisfactorily. Due to faulty application of plaster, a pressure sore developed around one of the wire ends and the infection extended to the bone. Radiograph shows the formation of the sequestrum.

CASE VI. A fifty-two year old man was admitted with an open fracture of the lower third of the right tibia. Débridement and pri-

mary closure were done, and multiple wire and plaster fixation was applied. However, due to inadequate padding around the wire ends and improper application of the plaster, a pressure sore developed around the middle wire, followed by infection of the bone. Five months later there was moderate callus at the fracture site but with a sequestrum at the middle wire tract. (Fig. 6).

Some of the earlier workers used larger-sized transfixion pins instead of wires. Serafin [*16*] described an apparatus consisting of four ball and socket joints and four turnbuckles which were attached to two transfixion pins. Once reduction is obtained under fluoroscopic guidance, the pins are incorporated with the plaster cast applied from the toes to the upper thigh. Carothers [*3*] uses a similar procedure as the Caldwell method whereby two pins are inserted through the proximal fragment and a third pin through the os calcis. The pins are locked with the Caldwell pin lugs to the bars of a Thomas, Braun or Pearson splint. Carothers attaches the distal pin to a ring, to enable him to rotate the distal fragment to the desired position. Griswold [*7*] reported on the use of a modified Böhler apparatus using double pin and plaster fixation. Ambulation is allowed early, and at the end of eight weeks the pins are removed and another cast is applied. Griswold and Holmes [*8*] reported twenty cases of delayed union of 259 fractured tibias treated with the double pin and plaster fixation. Naden [*12*] reported nineteen cases of non-union of 237 fractured tibias treated exclusively with the Roger Anderson apparatus. Both the Haynes and the Stader methods of external skeletal fixation consist of multiple pins inserted through both cortices and connected to a metal bar. No plaster cast is used. In 1936 Findlay [*6*] described a skeletal traction apparatus consisting of a light but rigid frame which supports two U-shaped yokes that hold the transfixion wires. After reduction is obtained, the wires are incorporated with the plaster cast. In this study, besides the Kirschner wires, no other apparatus was needed. Reduction was done either manually or by traction on a regular orthopedic table.

How long should the pins or wires be left *in situ?* West [*25*] maintains the pins in position until union is obtained. Griswold [*7*] removes the pins at the end of eight weeks. Trueta [*21*] leaves the wires for six to eight weeks. It was observed in this study that when the wires were left *in situ* longer than twelve weeks, wire tract infection was more frequent. For recent fractures, multiple wire and plaster fixation for eight to ten weeks, followed with plaster cast immobilization, was found satisfactory; the wires were kept longer if reduction was unstable. In the two cases with persistent angulation, multiple wire and plaster fixation for five and six weeks, respectively, followed with plaster cast immobilization, was sufficient to correct the persistent angulation.

Although the figures are small, the results of this study show that multiple wire and plaster fixation provides adequate immobilization and that it has a definite role in the treatment of fractures of the shaft of the tibia in adults. It has been found useful to counteract the tendency of the distal fragment to deviate laterally in fractures of the distal half of both the tibia and fibula. In open fractures when the surgeon believes that internal skeletal fixation is contraindicated and that plaster cast immobilization alone is inadequate, multiple wire and plaster fixation may be used. The procedure may also be used when the condition of the patient does not permit more extensive surgery.

SUMMARY AND CONCLUSIONS

This study is based on seventy-eight fractured tibias in adults, of which thirty-two were open fractures and forty-six were closed. Thirty-three were treated with plaster cast immobilization, thirty-four had multiple wire and plaster fixation, eight had internal skeletal fixation and three had skeletal traction. The technic of applying multiple wire and plaster fixation is described and possible complications are mentioned. The results obtained in cases treated with multiple wire and plaster fixation were compared with the results obtained in those treated with plaster cast immobilization as shown in Table II. Of the thirty-three cases immobilized in plaster cast, five had delayed union and one had non-union. In five other instances there was malunion due to change of position of the fragments. On the other hand, all the thirty-four fractures treated with multiple wire and plaster fixation healed within six months with no appreciable change of position or of alignment even among those with unstable reduction. Although these figures are

small, the results definitely show that multiple wire and plaster fixation provides adequate immobilization. It is indicated especially for unstable fractures of both the tibia and fibula to counteract the tendency of the distal fragments to deviate laterally. With multiple wire and plaster fixation, the use of internal skeletal fixation in open fractures may be avoided if the surgeon believes that such is contraindicated. With proper aseptic technic, very little risk of infection is involved in its application.

REFERENCES

1. Arzimanoglou, A. and Skiadaressis, G. Study of internal fixation by screws of oblique fractures in long bones. *J. Bone & Joint Surg.*, 34-A: 219–223, 1952.
2. Caldwell, E. H. Treatment of compound fractures: results in 100 cases. *Arch. Surg.*, 35: 368–372, 1937.
3. Carothers, R. G. Fractures of shaft of tibia and fibula. In: Surgical Treatment, part 2, pp. 1121–1136. Edited by Bancroft, F. W. and Marble, H. C. Philadelphia, 1951. J. B. Lippincott Co.
4. Cleveland, M. and Winant, D. M. Treatment of non-union in compound fractures with infection. *J. Bone & Joint Surg.*, 34-A: 554–563, 1953.
5. Fett, H. C. and Smith, J. M. Primary bone graft. *U.S. Nav. M. Bull.*, 47: 579–585, 1947.
6. Findlay, F. M. Inexpensive skeletal traction apparatus. *Am. J. Surg.*, 34: 395–396, 1936.
7. Griswold, R. A. Fracture of both bones of leg; treatment by modified Böhler method with new apparatus. *J. A. M. A.*, 104: 35–40, 1935.
8. Griswold, R. A. and Holmes, G. W. Double pin skeletal fixation in fractures of the leg. *Surg., Gynec. & Obst.*, 68: 573–575, 1939.
9. May, H. Double fractures and double non-union of shaft of tibia. *Am. J. Surg.*, 75: 796–801, 1948.
10. McLaughlin, H. L. and Ryder, C. T. Symposium on recent advances in surgery; open reduction and internal fixation for fractures of tibia and ankle. *S. Clin. North America*, 29: 1523–1534, 1949.
11. McMaster, P. E. The principles of treatment of compound fractures. *Am. J. Surg.*, 38: 468–473, 1937.
12. Naden, J. R. External skeletal fixation in treatment. *J. Bone & Joint Surg.*, 31-A: 586–598, 1949.
13. Orr, H. W. Traction in the treatment of fractures: editorial. *Surg., Gynec. & Obst.*, 69: 825–826, 1939.
14. Perkins, G. Rest and movement. *J. Bone & Joint Surg.*, 35-B: 521–539, 1953.
15. Senger, W. and Norman, J. S. One thousand consecutive fractures of both bones of leg. *Surg., Gynec. & Obst.*, 60: 516–518, 1935.
16. Serafin, P. J. New apparatus for reduction of tibia and fibula. *Am. J. Surg.*, 34: 394, 1936.
17. Speed, K. Treatment of fractures: editorial. *Am. J. Surg.*, 38: 459, 1937.
18. Stimson, B. B. The use of internal fixation in compound fractures. *Am. J. Surg.*, 74: 697–704, 1947.
19. Subcommittee on Orthopedic Surgery: Orthopedic Subjects. Military Surgical Manuals. Philadelphia, 1942. W. B. Saunders Co.
20. Thomson, J. E. The Kuntscher nail in the treatment of fractures of the tibia and fibula. *Surg., Gynec. & Obst.*, 94: 189–194, 1952.
21. Trueta, J. The Principles and Practice of War Surgery. St. Louis, 1943. C. V. Mosby Co.
22. Urist, M. R., Mazet, R. and McLean, F. C. The pathogenesis and treatment of delayed union and non-union. *J. Bone & Joint Surg.*, 36-A: 931–963, 1954.
23. Vom Saal, F. Intramedullary fixation of the tibia. *J. Bone & Joint Surg.*, 34-A: 86–95, 1952.
24. Watson-Jones, R. Fractures and Joint Injuries, 3rd ed. Baltimore, 1946. William & Wilkins Co.
25. West, W. K. Traction in the treatment of fractures of shaft of tibia and fibula. *J. A. M. A.*, 101: 2036–2038, 1933.

Investigation of Promethazine in a General Surgical Practice

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TECHNICS for management of the pre- and postsurgical period have been vastly improved in recent years, but many problems remain to disturb patient and surgeon [*1*]. The necessity for adequate control of postoperative pain, restlessness and confusion is universally acknowledged. Many potent and generally satisfactory analgesics are available, but all the sedative agents in common use, although numerous and diverse, have disadvantages, particularly in association with general anesthesia [*1*]. For example, on standard preanesthetic medication with the barbiturates the patient may reach the operating room in such profound slumber that his breathing may be too shallow to permit satisfactory induction under an inhalant agent.

The theory was advanced long ago that some non-hypnotic drugs with sedative potential might, through a synergistic action, increase the effect of various narcotics and other true hypnotic compounds. For example, since the introduction of antihistaminics it has been known that all such preparations are capable of producing varying degrees of somnolence, depending on the individual compound and on the dose; in recent years it has been learned that the combination of certain antihistamines with conventional pre- and postoperative sedative and analgesic agents will in some way reduce the amount of anesthetics needed and facilitate the relief of pain and restlessness during and after surgical trauma. Hence, for any given procedure smaller—and safer—amounts of pain-relieving agents should suffice.

Promethazine, a member of the phenothiazine series, has had widespread application for a number of years in the treatment of allergic disorders, notably those marked by exudation of fluid into the tissues [*2*]. Numerous pharmacologic and clinical studies have demonstrated the prolonged antihistaminic and antianaphylactic properties of the compound, as well as definite atropine-like and sedative effects [*3*]. An apparent potentiating effect of promethazine on the hypnotic action of barbiturates was reported in 1948 [*4*], and the antinauseant and antiemetic activities under various conditions have been described by a series of observers [*5–9*].

Decourt [*10*] refers to the state produced by the somnifacient action of promethazine and related compounds as "narcobiosis," in which essential metabolic functions of living cells, particularly those of the more sensitive nerve cells, are inhibited. The narcobiotic activity of promethazine (alluded to as "psychic sedation" by Holzmann and Josipowicz [*11*]) is believed to affect the reticular system of the brain, influencing encephalic function and the vomiting center; this is to be distinguished from true narcotic action, which is believed to correspond to simple activity on the physical structure of the cells, mainly those of the cortex. Aggressive reactions are rendered less intense by administration of promethazine, with little or no central nervous system depression [*11*]. The ability of the compound to lessen the intensity of anxiety would, in itself, suggest an application to pre- and postsurgical therapy [*7,12,13*].

METHOD

In this study, forty-seven patients (thirty females, seventeen males, ranging in age from eleven to eighty-one years) were subjected to forty-eight operations, usually multiple procedures with various complications. Thirty per cent of the patients were in the third and fourth

decades of life, 50 per cent were in the fifth and sixth, and 18 per cent were in the seventh to ninth. Several patients were very poor surgical risks.

Seventeen operations involved the abdominal cavity (procedures on the gallbladder and ducts, appendectomy, herniorrhaphy, resections of stomach and intestine, and lysis of adhesions). Thirteen involved the pelvis (hysterectomy, salpingo-oophorectomy; repair of urethrocele, rectocele, cystocele; colporrhaphy, conization and cauterization of the cervix, excision of pelvic cysts and cervical biopsy). Eight were operations on the thorax and back (mastectomy, local removal of tumors and excision of pilonidal cysts and infected sinus tracts). Three procedures involved the head and neck, such as thyroidectomy and tonsillectomy, and various minor procedures on the face were performed as part of some of the other operations. There were also seven local operations on the extremities or other parts, including removal of a lipoma from the thigh, excision of testis and surface cysts, moles or irritated skin (as from the perineum, for roentgen dermatitis), vasectomy and vein ligation. Six were rectal operations (hemorrhoidectomy, fistulectomy, removal of polyps and plastic procedures on the sphincters).

General *anesthesia* was used in all cases, usually a combination of sodium pentothal,® cyclopropane, oxygen and ether. In a series of this nature a considerable dosage of narcotics and hypnotics would normally be required for pre- and postoperative sedation and analgesia. Prior to the use of promethazine it was customary to administer 1½ gr. of a rapidly acting barbiturate two to three hours before operation, then 75 to 100 mg. meperidine* or ⅙ to ⅓ gr. total alkaloids of opium forty-five minutes before induction.

Preanesthetic Medication. In forty-four of the cases no barbiturates were administered before induction. Without my knowledge, two females who were to undergo extensive abdominal procedures and one male who was scheduled for hemorrhoidectomy received 1½ gr. of a rapidly acting barbiturate one and a quarter to four hours before the operation, in addition to the routine preanesthetic dosage of meperidine and atropine used for the entire group. The barbiturate should not have been given. For thirty-nine patients the preanesthetic medication consisted only of 75 or, in a few cases, 100 mg. meperidine and 1/150 gr. atropine administered ten minutes to two hours and forty minutes before induction (the average was about forty-five minutes).

Later in the series, having observed the sedation obtained with promethazine* postoperatively, we administered 25 mg. orally (in addition to meperidine and atropine) to eight patients before extensive abdominal operations. The promethazine was administered to six of these patients at the same time as the other preanesthetic drugs; two received the compound two hours and three and a half hours, respectively, before the other agents.

Antibiotics were used as indicated in the preoperative preparation of the patient, and the usual supportive measures, including transfusion, were employed during operation as required.

Postoperative Treatment. Every patient received an injection of 1 cc. (25 mg.) promethazine (some intravenously and the others intramuscularly) immediately on completion of the operation; a second injection of 1 cc. (intramuscularly in all cases) was given at bedtime on the same day. Twenty-seven of the patients, subjects of the severest surgery, received an additional intramuscular injection of 1 cc. promethazine in the morning of the first postoperative day. Thereafter the medication was administered orally, usually one tablet of 25 mg. in the morning and two tablets of the same potency at night. For twenty-one of the patients oral medication consisting of one tablet in the morning and one or two at night was begun on the first postoperative day.

No barbiturates were necessary for sedation after operation. Analgesics (codeine or meperidine in all but one case) were administered as required. One patient (No. 3) received a mixture of opium alkaloids.

Antibiotics were continued in the postoperative period as indicated, and in a few cases additional blood transfusions were administered.

Sedation with promethazine was continued only throughout the hospital stay. Eight patients were discharged in twenty-four to forty-eight hours (after excision of cysts, simple mastectomy and various other local proce-

* Demerol® hydrochloride, meperidine hydrochloride, Winthrop Laboratories, New York, N. Y.

* Phenergan® hydrochloride, promethazine hydrochloride, is available from Wyeth Laboratories, Philadelphia, Pa.

TABLE 1

PRE- AND POSTOPERATIVE MEDICATION IN FORTY-SEVEN PATIENTS UNDERGOING SURGERY

Sedatives and Analgesics Formerly Necessary		Sedatives and Analgesics Necessary in This Series	
Medication	Dose and Schedule	Medication	Dose and Schedule
Preoperatively			
Rapidly acting barbiturate	1½ gr., 2–3 hr. before surgery	Barbiturates	0
Opiates	⅙–⅓ gr.	Opiates*	0
or			
Meperidine	75–100 mg.	Meperidine	50–75 mg.
and	45 min. before surgery	and	45 min. before surgery
Atropine	1/150 gr.	Atropine	1/150 gr.
		Promethazine	25 mg. postoperatively with or 2–3 hr. before the other agents
Postoperatively			
Barbiturates	As required	Barbiturates	0
Opiates and other narcotics	As required	Opiates*	0
		Meperidine or codeine	Fewer and smaller doses
		Promethazine:	
		Severe operations	25 mg. intravenously or intramuscularly at end of operation; 25 mg. intramuscularly at bedtime day of operation; 25 mg. intramuscularly in morning of 1st postoperative day; thereafter orally, 25 mg. in morning, 25 or 50 mg. at bedtime
		Less severe operations	Same, without intramuscular injection morning of 1st postoperative day

* For 1 alcoholic patient, undergoing severe surgery, opium alkaloids required for some time before operation were continued during postoperative period.

dures). Fourteen patients were discharged in three to five days (after radical mastectomy, thyroidectomy, appendectomy, hemorrhoidectomy, rectal polypectomy, vasectomy, various reparative procedures and local operations of a severer nature than those of the previous group). Twenty-five patients were discharged in six to eleven days (after gastric resection, cholecystectomy and surgery of the common duct, hysterectomy, salpingo-oophorectomy, herniorrhaphy, resection of colon, plastic operations upon the rectum and vagina, and removal of large surface tumors). The patient who remained fourteen days was patient No. 3, an alcoholic man who had been admitted with recurrent pancreatitis and for whom an extensive operation was performed on the biliary tract.

RESULTS

Postoperative sedation was good in all patients but one, No. 3. With this exception, all slept quietly in the immediate postoperative period and during the subsequent nights in the hospital, and they were all adequately sedated without becoming stuporous throughout the daytime hours. If asleep they could be aroused easily whenever necessary, and exhibited no evidences of respiratory or circulatory depression from the sedation. Those who had received

promethazine in the preanesthetic medication before abdominal operations showed greater relaxation during the surgical manipulation.

The only exception, the alcoholic patient (No. 3), had been receiving a mixture of opium alkaloids to control his pain for some time prior to operation, and considerable doses of the same preparation were continued during the fourteen days of his hospital stay.

In all other patients fewer and smaller doses of analgesics sufficed to suppress postoperative discomfort. (Table 1.) This was especially notable after the thyroidectomies. Promethazine probably sedates and relaxes the patient to such a remarkable extent that his tolerance to physical and emotional distress is increased. Hence the desired response will be induced with smaller dosage volume of narcotics or less potent analgesic agents.

The operative wounds healed more rapidly, with less swelling, than is normally expected after such procedures.

The strong antihistaminic activity of the compound may have had a part in counteracting sensitivity reactions to the large and often frequent doses of antibiotics used, since no manifestations of allergy developed during the hospital period, and there were no side effects from the transfusions administered. One patient came to operation with a nonproductive cough, which subsided during the seven days of promethazine medication after the procedure. Another patient, sixty-nine years old and a poor risk, who was operated upon for cholecystitis, had suffered from asthma for years. His breathing difficulties subsided during the eight days he was under promethazine therapy. However, patient No. 17, a forty year old man who underwent herniorrhaphy, received an antibiotic for three days postoperatively and was discharged after seven days' hospitalization. Three days after his return home a severe allergic pruritus and swelling of the hands developed, which was relieved by 20 mg. of ACTH.

No vomiting occurred during operation and there was almost none postoperatively in this series. Most of the patients either had had no previous surgery, or no history of postoperative nausea and vomiting was obtained. In three cases, two females and one male (No. 3), a previous history of postsurgical emesis was elicited. Patient No. 44, a thirty-five year old woman who had been subjected to biopsy, cauterization, dilatation of the cervix and excision of hemorrhoidal tags and who never had been operated upon before, reported a slight feeling of nausea but did not vomit. Certainly the incidence of postoperative nausea and vomiting was very definitely reduced.

There was one death, that of a fifty-five year old man operated upon for ruptured appendix complicated by mesenteric thrombosis. Although an extremely poor risk, he survived the operation but died on the seventh day of atelectasis, prolonged postoperative ileus and low salt syndrome.

SUMMARY

Promethazine was administered parenterally or orally to a series of forty-seven patients operated upon under general anesthesia, in an effort to reduce the dosage of the standard narcotic and hypnotic agents required for preanesthetic and postsurgical sedation. Most of the operations were multiple procedures with various complications. Several of the patients were poor surgical risks.

For postoperative sedation each patient received 1 cc. (25 mg.) intravenously or intramuscularly immediately on completion of the operation. A second injection was given at bedtime on the same day. After the more extensive procedures a third injection was administered on the morning of the first postoperative day. All further postoperative sedation was administered by mouth, in doses of one tablet (25 mg.) each morning and one or two tablets at night. No other hypnotics were necessary.

Sedation was entirely satisfactory except in one case, in which the circumstances were unusual. The patients slept soundly at night and were maintained without restlessness on fewer and smaller doses of postoperative analgesics. Never at any time was there respiratory, circulatory or central nervous system depression from the sedative. Greater relaxation was obtained in the patients who received promethazine as part of the preinduction medication before abdominal operation, than in those who were treated by standard preanesthetic measures.

No untoward reactions occurred in response to blood transfusion or to antibiotic therapy during the hospital stay, nor were there any other local or systemic side effects.

No patient vomited during operation and

there was practically no postoperative emesis. Only one person reported a slight feeling of nausea, whereas considerably more nausea and vomiting might reasonably have been expected because of the extensive surgery performed, the poor condition of many of the patients, and a history of vomiting during and after previous surgery in at least three cases.

Healing of the wound was more rapid, with less swelling. It is our conclusion that promethazine must exert some effect in reducing tissue edema, thus promoting the healing process. Such effect is probably related to the ability of promethazine to reduce capillary permeability [*14–18*].

There was one death, which occurred one week after operation in one of the poor risk cases.

The results of this study have convinced us of the definite sedative activity of promethazine. On addition of the compound to the standard medication, barbiturates were omitted and smaller dosage volume of narcotics, and in some cases less potent analgesics, sufficed. Promethazine is now administered routinely to those patients undergoing surgery in this clinic.

REFERENCES

1. Lundy, J. S. New drugs and an era of analgesia and amnesia, President's Address to Section on Anesthesia, 105th annual meeting of the American Medical Association, Chicago, June 11–15, 1956. *J. A. M. A.*, 162: 97–101, 1956.
2. Silbert, N. E. Phenergan hydrochloride—a new antihistamine. *Ann. Allergy*, 10: 328, 1952.
3. Baird, K. A. Intramuscular phenergan. *Ann. Allergy*, 11: 752–753, 1953.
4. Winter, C. A. The potentiating effect of antihistaminic drugs upon the sedative action of barbiturates. *J. Pharmacol. & Exper. Therap.*, 94: 7–11, 1948.
5. Army, Navy, Air Force Motion Sickness Team: evaluation of drugs for protection against motion sickness aboard transport ships. *J. A. M. A.*, 160: 755–760, 1956.
6. Atkinson, W. S. Preanesthetic sedation and analgesia for intraocular operations done with local anesthesia. *Arch. Ophthal.*, 49: 481–490, 1953.
7. Baxter, R. W. et al. Three phenothiazine derivatives in anaesthesia. *Anaesthesia*, 9: 79–87, 1954.
8. Ambrus, J. L. and Ambrus, C. M. Motion sickness and antihistamines. *Lancet*, 1: 326, 1950.
9. Glaser, E. M. and Hervey, G. R. Further experiments on the prevention of motion sickness. *Lancet*, 1: 490–492, 1952.
10. Decourt, P. Narcobiotic activity and the mode of action of chlorpromazine. *Anesthesia*, 10: 221–232, 1955.
11. Holzmann, L. and Josipowicz, A. Clinical evaluation of promethazine for pre- and postanesthetic sedation—preliminary report. *Am. Pract. & Digest. Treat.*, 7: 939–942, 1956.
12. Weiss, W. A. and McGee, J. P. Promethazine, an adjunct to preoperative medication. *Ann. Surg.*, 144: 861–864, 1956.
13. Donovan, D. A study of the use of phenothiazine derivatives. *J. Irish M. A.*, 36: 45–47, 1955.
14. Halpern, B. N. et al. Action of antihistamine on the permeability of the capillaries. *Acta allergol.*, 1: 376–381, 1948.
15. Halpern, B. N. and Hamburger, J. A new synthetic antihistamine derived from phenothiazine. *Canad. M. A. J.*, 59: 322–326, 1948.
16. Halpern, B. N. et al. Prevention of acute experimental edema. *Experientia*, 4: 34, 1948.
17. Halpern, B. N. and Reber, H. Action of phenergan on local inflammatory phenomena, *Compt. rend. soc. de biol.*, 143: 257–259; also 928, 1949.
18. Brozzi, G. et al. Remarkable action of the antihistamine phenergan on permeability of small blood vessels. *Compt. rend. soc. de biol.*, 144: 503, 1950.

The Embryologic Basis for the Clinical Manifestations of Midgut Volvulus

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THE normal embryologic process of rotation of the gut must be understood for proper surgical management of rotation anomalies.

Most of our knowledge of the normal development of the gastrointestinal tract stems from the works of Mall [1] in 1898, and Frazer and Robbins [2] in 1915. Dott [3] first applied this knowledge to practical surgical problems in 1923. Gardner [4] in 1950 stressed the surgical significance of errors in rotation of the gut.

Embryologists divide the primitive intestinal tract into three parts: foregut (mouth to duodenojejunal junction), midgut (duodenojejunal junction to mid-transverse colon), and hindgut (mid-transverse colon to anus). The midgut is primarily involved in intestinal obstruction. Frazer and Robbins [2] have divided the process of rotation into three stages.

First Stage of Midgut Rotation (*Fig. 1*). The primitive intestinal tract hangs suspended in the sagittal plane on a common dorsal mesentery. As the bowel develops, the midgut loop bulges into the umbilical stalk as a temporary, physiologic umbilical hernia. At about the eighth week of intrauterine life a 90 degree counterclockwise rotation of the intraumbilical,

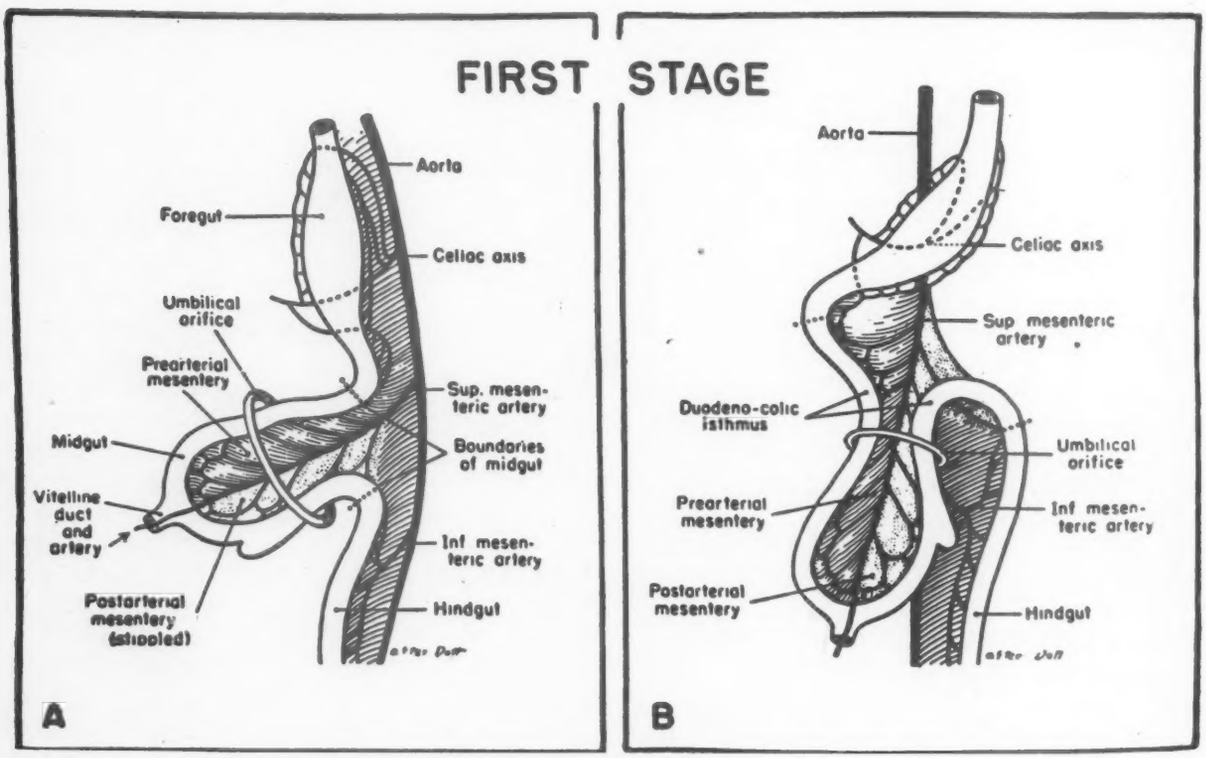

FIG. 1. From: GARDNER, C. E. *Ann. Surg.*, 131: 879–898, 1950.

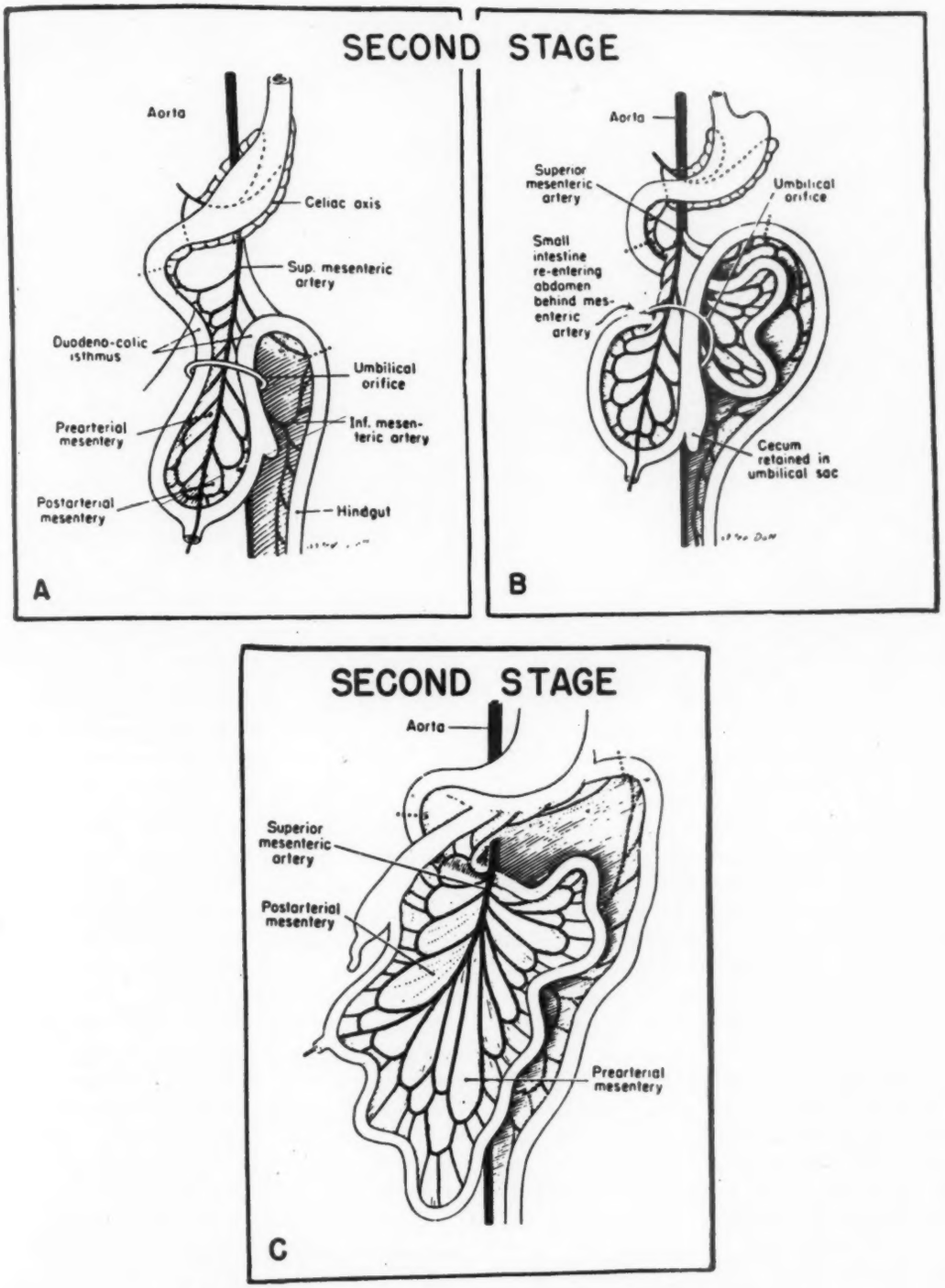

FIG. 2. From: GARDNER, C. E. *Ann. Surg.*, 131: 879–898, 1950.

midgut loop from the sagittal (A) to the horizontal plane (B) occurs. Failure of rotation beyond the first stage results in omphalocele.

Second Stage of Midgut Rotation (*Fig. 2*). During this stage the reduction and major rotation of the bowel occurs. The midgut loop, which occupies a position in the umbilical stalk at the beginning of the second stage (A), is reduced back into the peritoneal cavity (B). In so doing the loop rotates 90 degrees in a counterclockwise direction about the superior mesenteric artery as an axis. The proximal loop

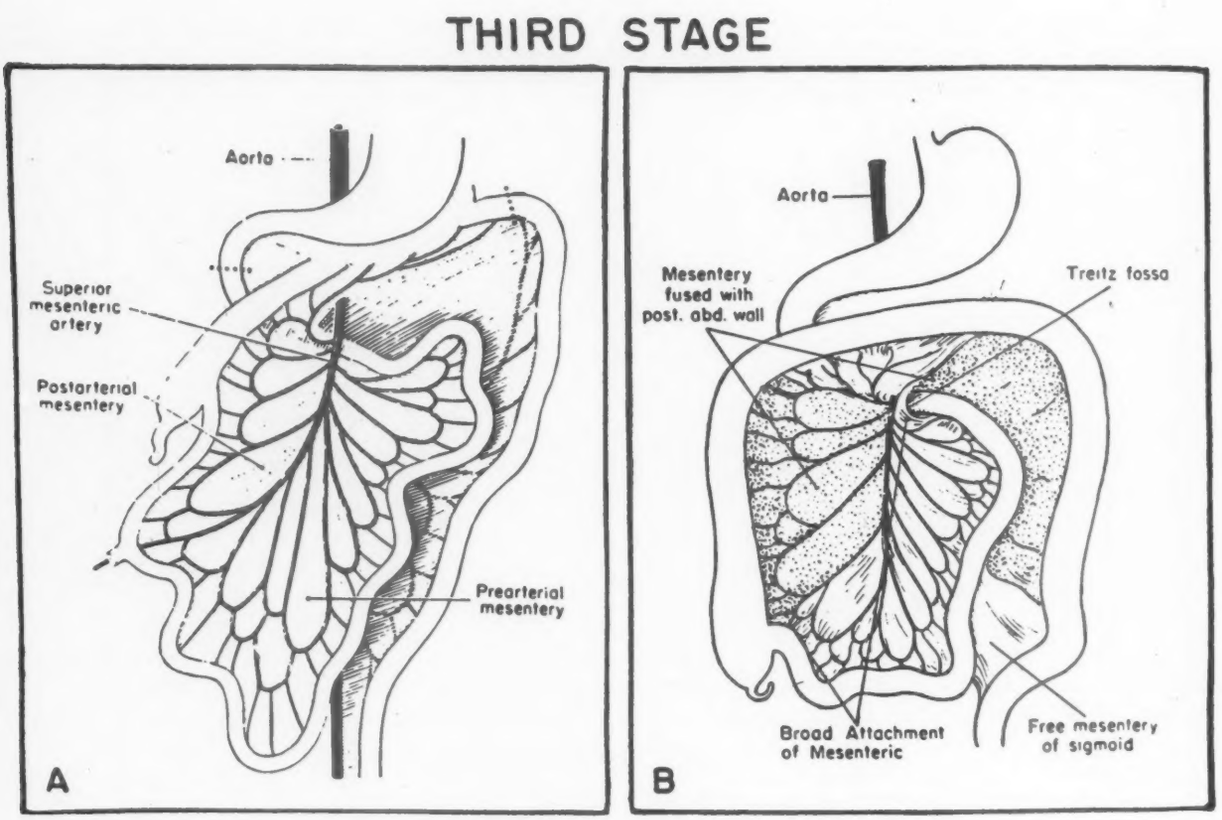

FIG. 3. From: GARDNER, C. E. *Ann. Surg.*, 131: 879–898, 1950.

of midgut first re-enters the peritoneal cavity under the mesenteric root (B). An orderly reduction of the remainder of the midgut loop then occurs, the cecum and ascending colon being reduced last. As the cecum and ascending colon straighten out, they are deflected to the right upper quadrant, completing the 180 degree counterclockwise rotation of the midgut loop about the mesenteric root (C).

The duodenum comes to lie under the origin of the superior mesenteric artery, while the colon passes anterior to it. The final result is a 270 degree rotation from the sagittal position of the midgut loop at the beginning of the first stage. This process occurs at about the tenth week of intrauterine life.

Anomalies of the second stage include nonrotation, malrotation, internal hernia and reversed rotation.

Third Stage of Midgut Rotation (*Fig. 3*). This stage is characterized by descent of the cecum from a subhepatic position (A) to the right lower quadrant, and fusion of its mesentery with the peritoneum of the right flank (B). Fixation of the cecum and ascending colon in the right flank gives the necessary broad attachment of the root of the small bowel mesentery from the ligament of Treitz to the right lower quadrant. The midgut loop, originally suspended from a narrow pedicle at the origin of the superior mesenteric artery, now acquires a broad, oblique attachment to the posterior abdominal wall. Absence of this attachment predisposes to volvulus of the midgut. This stage is completed at birth. Anomalies of the third stage include subhepatic cecum, retrocecal appendix and mobile cecum.

CASE REPORTS

CASE 1. A four week old white male infant entered Children's Memorial Hospital. He had vomited intermittently for five days prior to admission. The mother had noted blood in his stool the day before admission. The child had slept fitfully that night. The mother thought the child had abdominal pain because he occasionally drew his knees to his chest. A family history of Cooley's anemia, sickle cell anemia and diabetes mellitus was obtained. One parent was of Italian extraction.

Physical examination revealed a temperature

FIG. 4. Case 1. Child age one month. Barium enema was given before operation. The column of barium is arrested at the mid-transverse colon. Multiple dilated loops of small bowel indicate obstruction.

FIG. 5. Case 1. Child age thirteen months. Barium enema after release of volvulus, division of peritoneal band across duodenum and transfer of cecum to the left lower quadrant.

of 100.4°F., moderate abdominal distention and blood-stained stool in the diaper. Bowel sounds were absent. Hemoglobin was 9.5 gm. per cent; leukocytes were 9,200. The urine contained 1 plus albumin and 4 plus sugar. A flat film of the abdomen showed considerable gaseous distention of the bowel from the stomach to the rectum. This was interpreted as adynamic ileus. The child was given a transfusion that evening and was observed. The following morning a barium enema showed that barium had passed only to the mid-transverse colon. (Fig. 4.) Dilated, gas-filled loops of bowel with fluid levels, especially in the right lower quadrant of the abdomen, were seen. A flat film on that afternoon again showed gaseous distention of bowel with fluid levels. This suggested adynamic ileus on the basis of peritonitis. The child was operated upon late that evening. When the peritoneal cavity was entered, only small bowel presented. The intestinal mass was pulled out onto the abdominal wall. A midgut volvulus was recognized. The midgut had rotated around the superior mesenteric artery in a clockwise direction 360 degrees. The volvulus was reduced by rotating the intestinal mass in a counterclockwise direction around the superior mesenteric axis. Approximately 50 cm. of jejunum was necrotic. This was resected and a side-to-side anastomosis performed. A peritoneal band crossing the duodenum and attaching the cecum to the posterolateral abdominal wall was divided. The cecum was transferred to the left lower quadrant. The postoperative course was uneventful. The child was admitted to Childrens' Memorial Hospital at the age of six months for treatment of gastroenteritis, and at thirteen months for evaluation. The child has progressed satisfactorily. (Fig. 5.)

CASE II. A six week old Negro male infant was admitted to the University of Nebraska Hospital with persistent vomiting of one day's duration and abdominal distention. He had vomited at the age of three weeks and four weeks, with spontaneous remission of symptoms. The patient was dehydrated. The dehydration was corrected. Barium enema and gastrointestinal x-ray studies were considered

FIG. 6. Case 11. Barium enema examination performed the day before volvulus occurred. Cecum is present in the right upper quadrant of the abdomen.

FIG. 7. Case 11. An upright film of the abdomen before operation showing dilated loops of small bowel indicative of intestinal obstruction.

normal. (Fig. 6.) The child was markedly improved the following day. The cause of vomiting could not be established. He was discharged from the hospital.

The next afternoon the child was admitted again with abdominal distention and vomiting. Physical examination revealed a distended and tense abdomen with no bowel sounds. Flat film showed dilated gas-filled loops of bowel with fluid levels. (Fig. 7.) Hemoglobin was 7.4 gm. per cent and leukocytes were 34,350. A cut-down was performed and blood volume was restored. The child was operated upon for intestional obstruction, probably secondary to a midgut volvulus. When the abdominal cavity was entered, only loops of small bowel presented. A portion was gangrenous. The intestinal mass was pulled out onto the abdominal wall. A 360 degree clockwise volvulus was identified. This was reduced by rotating the intestinal mass in a counterclockwise direction. A peritoneal band crossing the duodenum and attaching the cecum to the posterolateral abdominal wall was divided. Twenty-two centimeters of gangrenous small intestine was resected. This left only 15 cm. of small intestine, approximately 60 per cent having been resected. On the seventh postoperative day there was profuse serosanguineous drainage from the abdominal incision. It was the impression that an enterocutaneous fistula had developed. At operation the following day the remainder of midgut not previously resected was gangrenous. Apparently the thrombosis had progressed to involve the remaining superior mesenteric vessels. The remainder of the midgut was resected. The duodenojejunal junction was anastomosed to the mid-transverse colon. On the second postoperative day following this procedure there was further serosanguineous drainage from the abdominal wound. At the third operation pancreatitis, as evidenced by fat necrosis, and a leak in the posterior anastomotic line of the duodenocolostomy were identified. The anastomosis was resected and anastomosis again performed. The patient failed to improve, the fistula recurred and the child died on the twentieth postoperative day following the last procedure. No autopsy was performed.

COMMENTS

An arrest in development at the second stage rotation results in malrotation and makes possible the occurrence of midgut volvulus. In infants and children with symptoms and signs of intestinal obstruction, midgut volvulus should be considered a likely cause. Wangensteen [5] states that, apart from atresia, midgut volvulus is the only frequent cause of intestinal obstruction in the newborn and young child. Ladd [6] has pointed out that atresia is likely to be accompanied with considerable vomiting from birth, whereas in volvulus, vomiting and abdominal distention occur after the lapse of some weeks.

The cardinal clinical features of midgut volvulus are as follows: *Signs and symptoms:* vomiting of bile, abdominal distention, bloody discharge from the rectum, silent abdomen. *X-ray findings:* Flat and upright films of the abdomen will show multiple, dilated, gas-filled loops of small bowel. Barium enema examination may show arrest of the barium at the mid-transverse colon.

Several technical points concerning midgut volvulus must be stressed. Most midgut volvuli occur in a clockwise manner around the superior mesenteric axis. The volvulus is released by rotating the intestinal mass in a counterclockwise direction. Gross [7] has stressed that releasing the volvulus without transferring the cecum to the left lower quadrant may be a fatal error. The child may die from duodenal obstruction. The peritoneal band must be released and the cecum transferred to the left lower quadrant to alleviate the possibility of high intestinal obstruction.

The two cases reported herein demonstrate several interesting points. The first child thus far has shown a normal growth pattern with a majority of the jejunum removed. The second case raises the question of whether or not an infant can survive after resection of the entire midgut. A number of cases of long term survival in adults following massive resection of the intestine for mesenteric thrombosis have been reported [8,9]. Berman of Indianapolis [10] will soon report a long term survival of an infant following resection of a majority of the midgut. This child was born with gastroschisis complicated by ileal and colonic atresia. After resection the jejunum was anastomosed to the mid-transverse colon. For many months diarrhea was difficult to control. Gradually the infant improved. Now, at three years of age, the child eats an unrestricted diet. He has only one or two stools daily.

The second case presents another interesting observation. This child experienced three episodes simulating intestinal obstruction before true obstruction occurred. The fact that a partial volvulus can spontaneously reduce itself logically explains this situation.

SUMMARY

1. The normal embryologic process of rotation of the gut must be understood for proper diagnosis and management of rotational anomalies.

2. Most midgut volvuli occur in a clockwise direction. They are released by rotating the obstructed intestine in a counterclockwise direction.

3. Reducing the volvulus and not releasing a peritoneal band obstructing the duodenum may be a fatal error.

4. An infant can survive after massive resection of intestine.

5. Progression of thrombosis in superior mesenteric vessels can occur as a postoperative complication of midgut volvulus.

6. Pancreatitis can complicate resection of the midgut with duodenocolic anastomosis.

REFERENCES

1. Mall, F. P. Development of the human intestine and its position in the adult. *Bull. Johns Hopkins Hosp.*, 9: 197–208, 1898.
2. Frazer, J. E. and Robbins, R. H. On the factors concerned in causing rotation of the intestine in man. *J. Anat. & Physiol.*, 50: 75–110, 1915.
3. Dott, N. M. Anomalies of intestinal rotation: their embryological and surgical aspects: with report of five cases. *Brit. J. Surg.*, 11: 251–286, 1923.
4. Gardner, C. E., Jr. The surgical significance of anomalies of intestinal rotation. *Ann. Surg.*, 131: 879–898, 1950.
5. Wangensteen, O. H. Intestinal Obstruction, 3rd ed., pp. 673–674. Springfield, Ill., 1955. Charles C Thomas.
6. Ladd, W. E. Congenital obstruction of the small intestine. *J. A. M. A.*, 101: 1453–1458, 1933.
7. Gross, R. E. The Surgery of Infancy and Childhood, p. 199. Philadelphia, 1953. W. B. Saunders Co.
8. Berman, J. K., Brown, H. M., Foster, R. T. and Grisel, T. L. Massive resection of the intestine. *J. A. M. A.*, 135: 918–919, 1947.
9. Berman, J. K., Habegger, E. D. and Billings, E. Massive resection of the small intestine: a six year followup study. *Am. J. Digest. Dis.*, 20: 152–156, 1953.
10. Berman, E. J. Personal communication.

Management of Injury to the Head in Patients with Multiple Injuries*

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WHEN a patient is brought to the hospital with an acute craniocerebral injury, there are many things to be noted in the evaluation of his condition. Perhaps the chief observation is to determine whether the patient has an adequate respiratory exchange, and whether he is in shock or is in a state in which shock is likely to develop. Prompt clearing of the respiratory tree by postural drainage, suction, or the introduction of an airway may save a life, or at least, by preventing further hypoxia, minimize the ultimate residual damage to the neurologic system.

Unless there is active bleeding from lacerations about the head, the presence of shock usually implies that there are serious injuries to other parts of the body, such as a fractured extremity and injuries to the chest or abdomen. When shock is not obvious, one is too often tempted to send the unconscious patient to the x-ray department. Immediate x-ray examination is rarely necessary in the management of the unconscious patient, and considerable harm may be done to the patient by an unwise, early general x-ray study. In the time required to transport the patient to and from the radiology department, plus the time necessary to obtain the films, shock may develop or respiratory embarrassment become acute, thereby increasing the dangers of further anoxia. If other injuries to the body make prompt radiologic examination necessary, however, films should be made of the skull at the same time; but it is important that trained personnel be present to make certain that the patient does not have his head twisted during the examination. Adequate information can generally be obtained by making lateral and anteroposterior exposures of the skull without turning the patient from the supine position. At the same time, a lateral view of the cervical spine should be made routinely, for the incidence of cervical injury is high in patients with trauma to the head.

In evaluating the status of injury to the brain, there are several criteria which should be used. Frequent observations and specific recording of these observations on the chart are of vital importance in the patient's subsequent management. For instance, clear indication for surgical exploration may depend on chronologic recording of changes in vital signs. The most important of the criteria are: (1) the state of consciousness, (2) the presence or absence of localizing neurologic signs, (3) the condition of the respiratory mechanism, (4) changes in the temperature, (5) the pulse rate and (6) the blood pressure.

A simple code for recording the state of consciousness is as follows: (1) *Coma* represents a profound state of unconsciousness, in which there is no voluntary response by the patient to any sort of painful stimulation. (2) *Stupor* represents a state of unconsciousness in which the patient makes little or no voluntary movements except when painfully stimulated, and then will move his extremities. (3) *Confusion* represents the condition of a patient who, although drowsy, is spontaneously moving his extremities.

As time passes during the observation of a patient, any lessening of the state of unconsciousness from that at the time of admission is a good prognostic sign. Any change to a deeper state of unconsciousness is a poor prognostic sign and often points to the necessity of

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an operative procedure to relieve intracranial bleeding.

Of the localizing signs which may be present or may develop during the management of an unconscious patient, the most important is a unilateral, dilated, fixed pupil. When this sign is present, immediate operation is indicated almost without exception, for it implies the presence of a localized clot, usually ipsilateral, and generally an extradural hematoma. Other important localizing signs are hemiparesis or hemiplegia, and convulsive seizures, particularly if the convulsion begins as a focal attack. Heavy, irregular, stertorous respiration, if not due to respiratory obstruction, is a bad prognostic sign, and often, when present with localizing neurologic signs or a deepening state of unconsciousness, indicates a surgical lesion. An early rise in temperature is a bad prognostic sign, generally implying brain stem damage of severe degree. A drop to a slow pulse rate implies an increase of intracranial pressure and may develop suddenly in the presence of an extradural hemorrhage. When a sudden drop in pulse rate occurs, there is an accompanying rise in the systemic blood pressure. The onset of a fast pulse after a slow pulse has been recorded is an exceedingly bad prognostic sign and generally represents a state in which the brain is no longer able to compensate for the increase in intracranial pressure.

It is obvious that in the early management of an acute injury to the head the chief decision to be made is whether or not the patient requires immediate surgical treatment. With one exception, it is rare that surgery is needed within a matter of minutes. This exception, although occurring infrequently in the total number of injuries to the head, occurs often enough that it is the chief concern of all who have the responsibility of caring for patients with craniocerebral trauma. This exception is the extradural clot, which demands immediate surgery to save life. Furthermore, the amount of permanent neurologic damage that will follow in a patient who survives is directly proportionate to the length of time between the onset of signs indicating an extradural hematoma and its surgical evacuation.

The classic picture of a brief period of unconsciousness, followed by a lucid interval, a second period of unconsciousness, and the development of focal convulsions, hemiplegia and a dilated, fixed pupil on the side of the lesion unfortunately is not always the picture presented by the patient with an extradural hematoma. Every patient who has remained unconscious or whose state of consciousness has deepened since injury and who has an inequality of his pupils (especially if one of the pupils is widely dilated and fixed to light) demands immediate surgical exploration on the assumption that an extradural clot is present. This neurologic picture can be simulated completely by acute subdural bleeding, and the differentiation between extradural and subdural bleeding can be made only by surgical exploration. Survival following evacuation of subdural bleeding is less frequent than that following removal of an extradural clot. This is due to the fact that subdural bleeding is generally bilateral and is spread over a great deal of the intracranial space.

Acute subdural bleeding occurs only in very severe intracranial injuries with laceration of major vessels within the dura, and consequently the generalized increase in intracranial pressure associated with it makes adequate evacuation of the clot exceedingly difficult. Even more important is the fact that it is often impossible to stop the bleeding from vessels at a point distant to the site of exploration although multiple burr holes may be made bilaterally in search for bleeding points. Nevertheless, if a patient with acute subdural bleeding is to be saved, it can be done only after such treatment is instituted.

Explorations of the posterior fossa may be indicated in any patient who has had exploratory trephining over the temporal and parietal areas without demonstrating pathologic disease to account for his neurologic disorder. Extradural hematoma in the posterior fossa is quite rare but should be suspected and looked for by exploratory burr holes in any patient who has a fracture line crossing the transverse dural sinuses or extending into the foramen magnum.

Most of the other acute cranial injuries, even when surgery is obviously indicated, can wait hours or even days if necessary while shock and serious injuries to other parts of the body are treated or the patient is being transported to a hospital for definitive surgery. At the proper time, when the patient is in a suitable condition to undergo major surgery, compound depressed fractures and other wounds of the head can be treated definitively. The same applies to simple depressed fractures and the complications of

injury to the head such as pneumocephalus or cerebrospinal fluid fistulas. Active bleeding from penetrating wounds of the skull or compound depressed fractures will require prompt surgery after the general evaluation of the other injuries, but it is not a question of moments before irreparable damage is done. In the meantime, crushing injuries to the chest, ruptured intra-abdominal organs or severe fractures of the extremities can be treated while further preparations are made to manage the injury to the head. Again, it should be stressed that during this waiting period, while shock or other injuries are being managed, the maintenance of a clear airway to eliminate the inherent damage to the cerebral structures which anoxia produces is extremely important. It is generally accepted that tracheotomy, as much as any part of the treatment, has saved innumerable lives in the management of severe injuries to the brain. Tracheotomy is even more important if the patient also has an injury to the chest, face or neck.

The value of exploratory trephining must be emphasized. In spite of careful repeated examinations using criteria to assess the state of the patient's cerebral injury, it may be impossible to be certain whether or not a specific patient's head injury presents a surgical lesion. Whenever there is doubt, exploratory burr holes should be made. It is better to perform many negative explorations than to be mistaken and have one patient die of an extradural hematoma who was not explored. The exploration will not add to the danger of death. In most instances bilateral burr holes can be made under local anesthesia within a matter of minutes. In the extremely restless patient only a few moments of general anesthesia are required for the placement of bilateral burr holes to settle the doubt which the clinical picture has presented.

Regarding patients with multiple injuries who do not require surgery for their head injury, the most common questions asked of the neurosurgeon by those treating the other injuries are: "Can an anesthetic be administered?" and "What sedatives or narcotics can be used?" If the patient has had nothing more than a concussion, any type of anesthetic is permissible. When applicable, local anesthesia is preferred to general anesthesia. Spinal anesthesia and the use of pentothal® as a single anesthetic agent are usually contraindicated. When a general anesthetic is required, it is advised that ether or nitrous oxide and oxygen be used as the chief anesthetic agents. It is exceedingly important that the endotracheal tube be left in place until the patient is over his tendency to vomit; and if the patient had any evidence of excessive secretions in his bronchial tree prior to anesthesia, tracheostomy is generally indicated before removing the endotracheal tube. Because morphine depresses respiration and masks pupillary signs, it is contraindicated; however, there are times when the judicious use of small quantities of demerol® are beneficial. Paraldehyde, thorazine® and chloral hydrate are the safest drugs for sedation of the restless patient.

Perhaps the most distressing of cerebral injuries are found in those patients deeply unconscious from the time of accident who do not present signs of a surgical lesion. These are the cases of closed head injuries in which signs of decerebration often develop, and the injuries are primarily to the mid-brain or brain stem. The extremities are in marked rigidity, pupils are pinpoint, respirations are irregular, there is a bilateral Babinski reflex and, characteristically, this decerebrate state can be accentuated by painful stimulation or the irritation that follows accumulation of secretions in the tracheobronchial tree. During this period of time the rigidity becomes markedly increased, the pupils momentarily dilate, and the respirations become more rapid. Although the picture of a brain stem injury is usually produced by contusion without signs of a surgical lesion, the same neurologic picture may be present in patients who have had successful removal of an intracranial clot, or after severe supratentorial contusion or laceration. In all patients presenting this neurologic picture there is an excessive amount of secretions in the tracheobronchial tree. These patients should undergo tracheotomy promptly because their period of unconsciousness will be a long one and there is no method which offers an equally efficient means of keeping the throat and trachea clear, except tracheostomy.

Within a matter of hours hyperthermia becomes a serious problem in patients with brain stem or mid-brain damage. The mortality rate is very high in these patients, and in those who survive, especially adults, serious neurologic residuals are common. In this group of patients we have had some encouraging results with a

new form of treatment. This treatment consists of chlorpromazine and external body cooling to produce a moderate degree of hypothermia.

For several years chlorpromazine has been used to control vomiting and allay restlessness in patients with injury to the head and to minimize the amount of other sedation that might be needed. We soon learned that the drug had other important properties; mild hypotension and hypothermia were often evident when large doses of the drug were employed. The sedative effect, the hypotension and the slight hypothermia were thought to be a protection against the production of further increased intracranial pressure and the damaging effects of that phenomenon. After contemplating the advantages of hypothermia for protection of the brain during elective surgical procedures it was decided to combine chlorpromazine with external body cooling for patients with severe injury to the brain. By reducing the body temperature to approximately 88°F. over a period of five to seven days, combined with large doses of chlorpromazine, a small but impressive group of patients has been successfully treated. It is thought that this form of treatment has protected the brain from the damaging effects of marked edema and thereby has further minimized the effects of hypoxia, not only from the reduced pressure and the reduced requirements for oxygen but also by markedly reducing the amount of excessive respiratory secretions normally present in these individuals. In any patient with a severely injured brain we believe this form of treatment offers considerable hope for recovery that could not be expected with other forms of treatment.

In conclusion, it should be said that approximately 30 per cent of patients hospitalized with injury to the head will require intracranial surgery, but among this group only a small number with acute intracranial bleeding must be operated upon in a very short time to save life. In the remaining patients, surgical or nonsurgical, the presence of multiple body injuries often presents situations that require more immediate attention than the injury to the head. In all patients our chief responsibilities with regard to the head injury are to protect the brain with an adequate and uninterrupted supply of oxygen plus repeated observations of the status of the neurologic system, using a few simple criteria of assessment, in order that an acute surgical emergency will not be discovered too late

Acute Perforation of the Gallbladder

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Acute perforation of the gallbladder demands the earliest attention because of the associated high morbidity and mortality. Operation for acute cholecystitis is too frequently delayed, either due to an erroneous diagnosis or to the still widely held opinion that perforation of the acutely inflamed gallbladder is rare. This presentation examines twenty-five consecutive cases of perforation of the gallbladder as seen from January, 1944 to March, 1956 at a large municipal hospital.

Perforations in acute cholecystitis have occurred into the peritoneal cavity with localization, without localization, and into a nearby viscus. Niemeier [9] classified all perforations of the gallbladder into: (1) perforation into the free peritoneal cavity; (2) perforation with formation of a localized abscess about the site of the gallbladder; (3) perforation with formation of a chronic biliary fistula. This study is limited to the problem of acute perforation in cholecystitis.

Chronic perforations with a passage of a gallstone into the gastrointestinal tract with subsequent intestinal obstruction occurred fourteen times at this hospital during the period covered in this study. These chronic perforations were recently reported by one of our staff under a study of gallstone ileus [4]. Chronic perforation into the gastrointestinal tract is an entirely different clinical entity in our opinion. There is usually no acute episode associated with this type of perforation, probably due to the fact that the gallbladder adequately drains itself into the gastrointestinal tract, thereby effecting a spontaneous internal cholecystostomy.

Incidence. During the twelve year period under consideration, 542 patients were admitted to the Queens Hospital Center with a diagnosis of acute cholecystitis; perforations occurred in 25 of these patients, for an incidence of perforation of 4.6 per cent.

Table 1 shows the incidence of acute perforations as reported by others compared to our series. The incidence varies from 4 to 15 per cent.

Table 1
INCIDENCE OF ACUTE PERFORATION

Reference	Year of Report	Cases of Acute Cholecystitis (No.)	Cases of Perforation (No.)	Incidence (%)
Stone, Douglass [15]	1939	170	17	10.0
Holtz [8]	1939	574	69	12.0
Wallace, Allen [16]	1941	415	64	15.4
Glenn, Moore [6]	1942	350	25	7.1
Cowley, Harkins [3]	1943	490	23	4.7
Pines, Rabinovitch [10]	1954	1480	90	6.0
Morse, Krynski, Wright	1956	542	25	4.6

The most frequent type of perforation, both in our study and as reported in the literature, was the perforation with localized abscess formation. This occurred in thirteen of our cases. The next most frequent type of perforation was the free perforation into the peritoneal cavity which occurred in ten of our patients. In two cases the perforation had occurred into the liver. Glenn and Moore [6] in 1942 reported perforation into the liver in four of twenty-five cases. Among the ninety cases reported by Pines and Rabinovitch [10] in 1954, fifty-three patients had localized abscess formation, and perforation into the liver had occurred in three.

Sex and Age. The majority of our patients were women with a ratio of 60 per cent to 40 per cent. Other series show about the same ratio and this probably reflects the increased incidence of cholecystitis in women. All our patients were fifty years of age and most of them were between sixty and seventy years old.

Duration of Present Illness. Table II shows the duration of the present illness. In almost half of our patients perforations occurred within seventy-two hours of onset of symptoms. Although twelve of the twenty-five patients were operated upon within twelve hours of admission, most had waited from one to three days after onset of illness to come to the hospital.

TABLE II
DURATION OF PRESENT ILLNESS

Duration	Cases (No.)	Total Cases (%)
1–3 days	12	48
4–7 days	5	20
1–2 weeks	6	24
1–3 months	2	8

Signs and Symptoms. Nausea, vomiting and pain in the right upper quadrant of the abdomen were present in all but two of the patients. Jaundice was present only twice. A history of chronic disease of the gallbladder such as radiographically visualized calculi, recurrent cholecystitis and intolerance to fatty food was found in the majority of cases. The average patient had a white blood cell count above 15,000 and a temperature elevation above 38°C.

TABLE III
PREOPERATIVE DIAGNOSES

Diagnosis	Cases (No.)	Total Cases (%)
Acute cholecystitis with perforation	6	24
Acute cholecystitis	13	52
Acute appendicitis	2	8
Incarcerated femoral hernia	1	4
Perforated peptic ulcer	1	4
No diagnosis recorded	2	8
Totals	25	100

Diagnosis. Table III shows that the correct diagnosis was arrived at preoperatively in six patients or 24 per cent of the cases. In the literature, the preoperative diagnosis was made or suspected in from 12 per cent to 17 per cent of cases. In patients presenting the clinical picture of acute peritonitis, many diagnoses were entertained which may have been due to lack of awareness that a perforated gallbladder may be a source of peritonitis.

TABLE IV
MORTALITY RATE IN DIFFERENT TYPES OF PERFORATIONS

Reference	Cases (No.)	Localized Abscess (% mortality)	Free Perforation (% mortality)
Pines and Rabinovitch	90	15	24
Cowley and Harkins	25	25	16
Judd and Phillips	61	25	50
Morse, Krynski, Wright	25	38	60

Type of Operation. Cholecystectomy was performed in twelve of the twenty-five cases, cholecystostomy in ten; there was no surgery for gallbladder in three cases. The majority of authors report that cholecystectomy is the operation of choice [5,14]. One patient was operated upon for a mistakenly diagnosed incarcerated femoral hernia; a free perforation of the gallbladder was found at autopsy the following day.

Type of Perforation and Associated Mortality. Six patients with free perforations into the peritoneal cavity died, resulting in a 60 per cent mortality rate. Of the thirteen patients with perforation and localized abscess formation, five died, for a mortality rate of 38 per cent. (Table IV.)

Of the two patients having perforations into the liver, one died. Our surgical mortality was five deaths out of nine patients with free perforation who were operated upon, and five deaths among the thirteen patients with localized abscess who were operated upon.

Of the twelve patients in whom cholecystectomies were performed, only three died whereas of the ten patients in whom cholecystostomies were performed, five died. When the condition of the patient permitted cholecystectomy, the mortality rate was 25 per cent, but when the condition of the patient precluded cholecystectomy, the mortality rate was 50 per cent. This is consistent with reports of other authors.

Two patients died before their general condition permitted surgery, and a femoral herniorrhaphy was performed on an additional patient due to a mistaken diagnosis. Generalized peritonitis was found at autopsy in all three cases. This agrees with Schmitz, Schlosser and Harkins [*14*] who state that the mortality rate in non-operated cases of perforated gall bladder is 100 per cent.

COMMENTS

Perforation occurs in cholecystitis when distention and vascular impairment lead to necrosis of the gallbladder wall. Stone pressure is another factor in the mechanism of perforation. In all recorded series of perforations, stones were found with great frequency, and stones were mentioned in the operative reports in all our cases. There have been cases of biliary peritonitis without visible perforation in the biliary tree and several theories have been advanced [*16*]: (1) previous perforation with sealing of the site; (2) deep perforation of the sinuses of Rokitansky; (3) perforation of the aberrant ducts of Luschka or of one of the small accessory bile ducts leading directly from the liver to the gall bladder; and (4) reflex of trypsin damaging the gall bladder with subsequent escape of bile.

We have noted that it is impossible to predict in which patients with acute cholecystitis perforations are going to occur. Most perforations tend to localize in the hepatic area and the patients do not appear critically ill. Many of those in whom perforations occur without localization present a picture of overwhelming sepsis and arrive at the hospital in a moribund state. Even though mild symptoms initiated the attack, the process advanced to perforation, and to death in 50 per cent of the cases in which perforations occurred. Relatively mild cholecystitis can suddenly turn into a generalized peritonitis with overwhelming sepsis. Early hospitalization and surgery could have prevented these catastrophic complications.

Delay in operation is often due to the misconception that edema, hyperemia and adhesions make early operation hazardous. Ross in 1950 [*13*] questioned many surgeons concerning operative difficulty in early surgery of the gallbladder. He learned that the technical difficulties increased after four days and remained so for many weeks and months. This contradicts the accepted theory that a "delay" will diminish surgical difficulties.

Perforations occur more frequently in older people and they die because localization does not materialize. This should be considered before a "cooling off" period is initiated in an older patient with acute cholecystitis. Every attempt should be made at operation to remove the gallbladder rather than merely to drain it, since the results are better. However, the condition of the patient should be the determining factor in the choice of procedure.

It is understood that time be allowed for preoperative preparation. This includes hydration, gastric suction and treatment of any cardiac or pulmonary condition present.

The correct diagnosis of perforation is not always manifest since pain, tenderness and a mass are commonly found in acute cholecystitis. The correct diagnosis was made in six of our cases, but in everyone of these, disease of the gallbladder was known to have existed and the patient was critically ill; three of the six patients subsequently died. These three were admitted to the hospital in a moribund condition and the outcome would probably not have been altered regardless of therapy. Had surgery been performed during the previous hospitalization for acute cholecystitis, the attack resulting in perforation never would have developed. We strongly recommend immediate surgery for the treatment of the acute episode, and for the prevention of the later gallbladder sequelae.

SUMMARY AND CONCLUSIONS

1. Twenty-five consecutive cases of perforation of the acutely inflamed gallbladder during the twelve year period from January, 1944 to March, 1956 are presented. During this period 542 patients were admitted with a diagnosis of acute cholecystitis, for an incidence of perforation of 4.6 per cent and a mortality rate after perforation of 44 per cent.

2. The twenty-five cases were classified into:

   (a) Free perforation with no localization within the peritoneum—ten cases.
   (b) Free perforation with localization in the gallbladder area—thirteen cases.
   (c) Perforation into a viscus—two cases into the liver.

3. There is little correlation between the clinical picture and impending perforation.

4. The mortality rate for untreated patients is 100 per cent.

5. Delay of operation does not make surgery easier.

6. Operation should not be delayed because symptoms are subsiding.

7. Interval cholecystectomy should be performed in chronic cholecystitis as a prophylactic measure to prevent perforation.

8. Early operation should be considered in every patient over fifty years of age when a diagnosis of acute cholecystitis is made.

REFERENCES

1. Behrend, M. Acute cholecystitis. *J. Internat. College Surgeons*, 13: 649, 1950.
2. Colcock, B. D., McManus, J. E. Experiences with 1356 cases of cholecystitis and cholelithiasis. *Surg., Gynec. & Obst.*, 101: 161–172, 1955.
3. Cowley, L. L., Harkins, N. H. Perforation of the gall bladder. *Surg., Gynec. & Obst.*, 77: 661, 1943.
4. Deckoff, S. Gallstone ileus. *Ann. Surg.*, 142: 52, 1955.
5. Diffenbaugh, W. G., Sarver, F. E. Gangrenous perforation of the gall bladder. *Arch. Surg.*, 59: 742, 1949.
6. Glenn, F., Moore, S. W. Gangrene and perforation of wall of gall bladder. *Arch. Surg.*, 44: 677, 1942.
7. Heuer, G. J. Surgical aspects of acute cholecystitis. *Ann. Surg.*, 105: 758, 1937.
8. Holtz, R. Perforated cholecystitis. *Am. J. Surg.*, 44: 706, 1939.
9. Niemeier, O. W. Acute free perforations of the gall bladder. *Ann. Surg.*, 99: 922, 1934.
10. Pines, B. and Rabinovitch, G. Perforation of gall bladder in acute cholecystitis. 140: 170, 1954.
11. Moragues, V. and Simon, T. R. Perforation of the gall bladder. *Ann. Surg.*, 132: 282–286, 1950.
12. Richardson, M. Discussion. *Tr. Am. S. A.*, 23: 217, 1905.
13. Ross, F. D. and Boges, J. D. Studies in acute cholecystitis. *Surg., Gynec. & Obst.*, 91: 217, 1953.
14. Schmitz, E. J., Schlosser, R. J. and Harkins, H. N. Perforation of the gall bladder. *West. J. Surg., Gynec. & Obst.*, 61: 469–475, 1953.
15. Stone, W. W. and Douglas, F. M. Perforation of the gall bladder. *Am. J. Surg.*, 45: 301–303, 1939.
16. Wallace, G. H. and Allen, A. W. Acute cholecystitis. *Arch. Surg.*, 43: 762, 1941.

Jejunogastric Intussusception Following Subtotal Gastrectomy

AN ILLUSTRATIVE CASE REPORT

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THE surgical rearrangement of gastroenteric continuity following subtotal gastrectomy renders the new stoma vulnerable to unpleasant complications and sequalae. The appreciation of these complications aids in the constant assessment of the relative merits of the various surgical procedures devised for the treatment of duodenal or gastric ulcers. It seems, therefore, proper to continue to assemble data pertinent to this assessment. The well known complications such as stoma dysfunction, dumping syndrome and nutritional deficiencies, often have been utilized in these appraisals. It is desirable, therefore, to add a rare complication, "the invagination of the jejunum into the cavity of the gastric pouch left after subtotal gastrectomy." This complication has been described only occasionally in the American literature.

In a survey of the literature, jejunogastric intussusception has been noted more frequently following simple gastrojejunostomy than in gastrojejunostomy following subtotal gastrectomy. The first gastrojejunostomy was performed in 1881 [*16*], but it was not until 1917, or thirty-six years later, that the first case of jejunogastric intussusception was recorded by Steber [*14*]. A case of Bozzi, supposedly noted in 1914 and mentioned by Aleman [*1*], is not listed in Aleman's bibliography nor is it possible to find it in the available literature.

Since the first recorded instance of this complication, approximately eighty cases of jejunogastric intussusception have been reported. These include intussusception following simple gastrojejunostomies, as well as those following subtotal gastrectomies.

In studying the various individual reports, one gains the impression that three types of intussusception occur equally in subtotal gastrectomies and gastrojejunostomies. We shall point out that this is incorrect. The three types of reported intussusceptions are: (1) afferent segment of jejunum (Fig. 1.); (2) efferent segment of jejunum (Fig. 2.); and (3) combined afferent and efferent segments of jejunum. (Fig. 3.)

A careful review of the literature reveals that these three types of intussusception are noted only in simple gastrojejunostomies. Contrary to the assumption in the literature, the invagination of afferent or of the combined afferent and efferent segments of jejunum into the gastric pouch following subtotal gastrectomy has never been observed. The only type of intussusception ever noted following subtotal gastrectomy is the invagination of the efferent jejunal segment. (Fig. 4.) The evidence for this contention is obvious in the tabulation of the largest number of recorded cases of retrograde intussusception following subtotal gastrectomy. (Table 1.) The analysis of the subject of invagination of the jejunum into the total stomach following simple gastrojejunostomy is not included in this presentation.

Other deductions referable only to postgastrectomy intussusception, and heretofore not appreciated in the literature, may be obtained from the recorded data in our tabulation. Fifteen recorded cases (including our own), show that in nine patients the invagination of the efferent jejunal segment occurred through posterior Polya anastomoses, one through anterior Polya, one through Billroth II, one through "anterior Billroth II," and

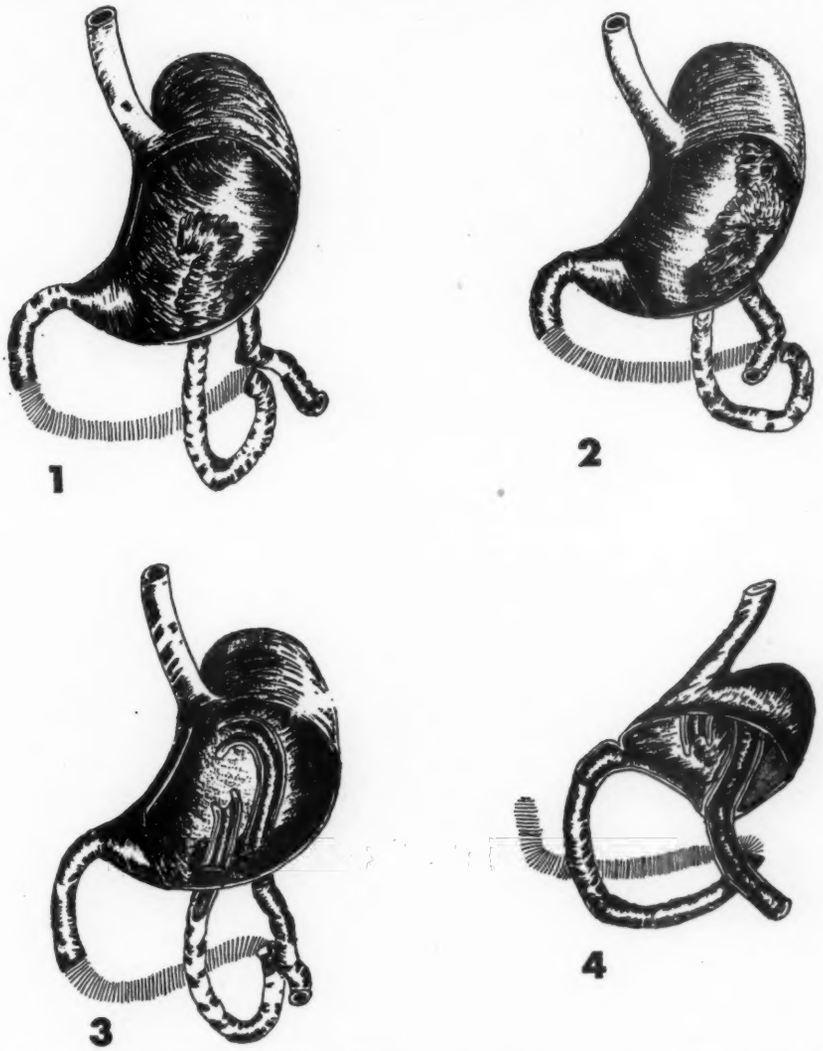

FIG. 1. Intussusception of the afferent segment of jejunum into the stomach following gastrojejunostomy.

FIG. 2. Intussusception of the efferent segment of jejunum into the stomach following gastrojejunostomy.

FIG. 3. Intussusception of afferent and efferent segments of jejunum into the stomach following gastrojejunostomy.

FIG. 4. Intussusception of the efferent jejunum into gastric pouch after partial gastrectomy. This is the only type of invagination recorded in the literature.

in three, the type of anastomosis was not described.

In thirteen cases the intussusception developed at least two years after the surgical procedure. The length of invaginated efferent jejunum varied from 8 to 70 cm. In all fifteen patients, epigastric pain and hematemesis were the constant symptoms. A failure to reduce the intussusception by immediate surgical intervention caused death in four cases. Our own case presented a special problem; that of irreducible intussusception fixed within the cavity of the gastric pouch remaining after subtotal gastrectomy. It required a special surgical procedure herein described.

CASE REPORT

A. D., a fifty-six year old man, stated that twenty-four hours prior to his admission to the hospital sudden, severe, upper epigastric pain

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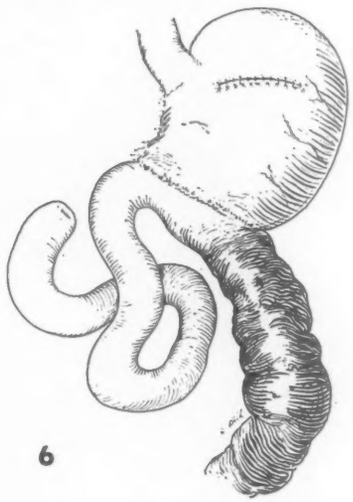

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FIG. 5. An "open" reduction of a fixed jejunogastric intussusception. The head of the intussusceptum is easily found by finger examination of the gastric cavity. An effective force then may be applied to accomplish an easy reduction.

FIG. 6. The incision in the anterior gastric wall is repaired. The swollen, liberated intussusception assumes normal place in the jejunal continuity.

developed, occurring in rhythmic waves. These came on in periods of about five minutes, lasted one to two minutes, and subsided to a constant dull ache. At the height of the rhythmic pain, the patient doubled up in convulsive agony. These pains came on with increasing frequency and lasted for longer periods of time. Within two hours of the onset of the pain, the patient vomited bloody material and thereafter vomited at intervals of one to three hours.

The patient's past history revealed a perforated duodenal ulcer complicated by peritonitis and multiple intraabdominal abscesses three years prior to his present illness. One year following the episode of perforated ulcer, subtotal gastric resection was performed at another institution.

The physical examination revealed a man who was acutely ill and doubled up in knee-breast posture, moaning with pain. His rectal temperature was 100°F.; pulse, 100; blood pressure, 110 mm. Hg systolic; 70 mm. Hg. diastolic. The upper half of his abdomen had a board-like rigidity and was exquisitely tender on palpation. The lower part of the abdomen was tender but not rigid. No masses could be felt. The rectal examination was negative. The erythrocyte count was 3,900,000, hemoglobin 12 gm. per cent, and the leukocyte count 12,000. The urine, Wassermann and Kahn tests were negative. A clinical diagnosis of perforated stomal ulcer was made. A roentgenogram of the abdomen was not taken because the patient was unable to cooperate.

At exploration, a peculiar, soft mass was palpated posterior to the gastric pouch. The jejunogastric anastomotic line was cleared of its adhesions in order to inspect this area for a possible perforated ulcer. The efferent jejunal segment appeared to emerge from the retrogastric space and lead to the soft mass in this region. There were no physical signs which in any way suggested a jejunogastric intussusception. The impression gained on direct inspection and by palpation was that a strangulated loop of jejunum became situated dorsal to the stomach, possibly through a rent in the transverse mesocolon. The operative diagnosis of jejunogastric intussusception was made only by a process of exclusion.

It was not possible to reduce the intussusception by pulling on the efferent jejunal segment, nor by pushing or "milking" the mass out of the dilated gastric pouch. These unsuccessful maneuvers suggested that the intussuscepted loop, being hidden within the gastric cavity, could not be grasped properly to exert an effective force. Therefore, an "open" reduction was decided upon.

A transverse incision was made into the anterior gastric wall above the anastomotic scar. (Fig. 5.) The incision was large enough

TABLE I

Reference	Sex and Age (yr.)	Initial Pathology and Type of Anastomosis After Partial Gastrectomy	Interval Between Gastrectomy and Intussusception (yr.)	Main Symptoms Diagnosis and X-ray	Treatment	Results	Findings at Operation or at Necropsy and Length of Bowel Invaginated into Stomach
Lundberg [9], 1922.....	F, 41	Cancer of stomach(?); resection of pylorus; Billroth II	11	Epigastric pain; hematemesis	Non-surgical	Died	15 cm. of efferent jejunum invaginated into stoma and this into afferent loop
Baumgartner [4], August 1938	F, 44	Peptic ulcer; Billroth II	12	Epigastric pain; hematemesis	Reduction at laparotomy	Recovered	80 cm. of efferent jejunum
McNamara [10], August 1944	M, 60	Duodenal ulcer; partial gastrectomy	2 mo.	Epigastric pain; hematemesis	Non-surgical	Died	50 cm. of gangrenous efferent jejunum
Aleman [1], January–June 1948	M, 46	Duodenal ulcer; Billroth II; posterior Polya	19	Epigastric pain, hematemesis; x-ray showed intussusception	Reduction at laparotomy	Recovered	50 cm. of efferent jejunum
Almeida, Dino, Lombardi [2], November 1948	M (age not given)	Type of anastomosis not stated	20	Epigastric pain; hematemesis; not diagnosed	Non-surgical	Died	? cm. of efferent jejunum
Grimes [7], March 1949	M, 55	Duodenal ulcer; posterior Polya	4	Epigastric pain; hematemesis	Enterostomy for feeding	Died	17 cm. of efferent segment of jejunum
De Toeuf [6], June 1949.	M, 42	Pyloric ulcer; type of anastomosis not stated	4	Epigastric pain; hematemesis; no x-ray	Laparotomy; resection of necrotic jejunum	Died	50 cm. of necrotic efferent jejunum
Puech Leao [13], August 1949	M, 37	Peptic ulcer; posterior Polya	4	Epigastric pain; hematemesis; x-ray showed intussusception	Reduction at laparotomy	Recovered	40 cm. of efferent jejunum
Nogueira [12], September 1949	F, 27	Duodenal ulcer; posterior Polya	3	Epigastric pain; hematemesis; diagnosed as intussusception	Laparotomy; reduction; resection of necrotic jejunum	Recovered	50 cm. of efferent jejunum
Vink [15], 1950.....	Not stated, 53	Duodenal ulcer; posterior Polya	11 days	Hematemesis	Laparotomy; reduction	Recovered	8 cm. of efferent jejunum
Arduino [3], 1951.....	M, 42	Duodenal ulcer; posterior Reichel-Polya	8	Epigastric pain; hematemesis	Resection of gangrenous efferent segment	Recovered	8 cm. of efferent jejunum
Muhlberghuber [11], November 1952	M, 53	Duodenal ulcer; antecolic Reichel-Polya	14	Epigastric pain; hematemesis	Laparotomy; resection of 70 cm. of gangrenous jejunum	Recovered	70 cm. of efferent jejunum
Lavadia, Haynes, DeBakey [8], June 1953	M, 64	Cancer of stomach; posterior Polya	8	Epigastric pain; hematemesis; diagnosed as obstruction	Laparotomy; reduction	Recovered	40 cm. of efferent jejunum
Berthon, Poirier, Fort [5], March 1954	F, 39	Duodenal ulcer; posterior Polya	3	Epigastric pain; hematemesis; x-rays; diagnostic	Laparotomy; reduction	Recovered	50 cm. of efferent jejunum

to admit two fingers. The jejunal segment was easily reduced by pushing it out of the swollen stoma. The intussusception consisted of 50 cm. of edematous, engorged and cyanotic segment of the efferent jejunum. After reduction, the incision in the stomach was closed in two layers. (Fig. 6.) The jejunum, which appeared viable, was neither fixed nor resected. The patient made an uneventful recovery and is well today, twelve years after the operation.

COMMENTS

The surgical literature records only fourteen cases of jejunogastric intussusception following subtotal gastrectomy. This includes a recent case of Lavadia [8]. The case presented by us increases the total number of recorded cases to fifteen. The experience of surgeons with this type of complication is extremely rare. Lack of experience, at least in this case, was responsible for failure in diagnosis of the condition preoperatively. The clinical diagnosis was that of a perforated stomal ulcer. For this reason, no barium roentgenogram was taken. Such a roentgenogram should produce a diagnostic picture of the disease.

CONCLUSIONS

1. The fifteenth case of jejunogastric intussusception following subtotal gastrectomy is presented.

2. An "open" method of reduction of an irreducible intussusception is described.

3. An analysis of the recorded cases uncovers the following facts: (a) only the efferent segment of jejunum invaginates into the gastric pouch left after subtotal gastrectomy; (b) posterior Polya anastomosis after subtotal gastrectomy is the gastroenteric restoration in which retrograde invagination of efferent jejunum most frequently occurs; (c) most common symptoms are epigastric pain and hematemesis; (d) the intussusception is a late complication; most of them occur several years after the subtotal gastrectomy; and (e) the therapy consists of immediate surgical intervention.

REFERENCES

1. Aleman, S. Jejunogastric intussusception: a rare complication of the operated stomach. *Acta radiol.*, 29: 383–395, 1948.
2. Almeida, A. D. de and Lombardi, I. Invaginacao retrograda postgastrectomia. *Rev. cir. São Paulo*, 14: 161–171, 1948.
3. Arduino, E. Intussuscepçao retrógrada de alça efente após gastrectomia subtotal. *Bol. Col. brasil cir.*, 25: 115–120, 1952.
4. Baumgartner, W. Von Jejuno-gastric intussusception after gastrectomy. *Zentralbl. f. Chir.*, 65: 1907–1909, 1938.
5. Berthon, A. P. and Fort, J. A case of acute jejuno-gastric intussusception after gastrectomy. *Arch. mal. app. digest.*, 43: 621–624, 1954.
6. DeToeuf, G. Intussusception jejuno-gastrique retrograde apres gastrectomie. *Acta chir. belg.*, 6: 410–415, 1949.
7. Grimes, A. E. Retrograde intragastric intussusception of the jejunum following subtotal gastrectomy. *Ann. Surg.*, 129: 404–407, 1949.
8. Lavadia, P. L., Jr., Haynes, B. W., Jr. and Debakey, M. E. Retrograde jejuno-gastric intussusception. Review of literature and report of a case. *Am. Surgeon*, 19: 507–513, 1953.
9. Lundberg, S. Retrograde dunndarminvagination nach gastroenterostomie. *Acta chir. Scandinav.*, 54: 423–433, 1922.
10. McNamara, E. L. Retrograde jejunogastric intussusception through a subtotal gastrectomy stoma. *Ann. Surg.*, 120: 207–210, 1944.
11. Muhlberghuber, K. Retrograde invagination of small intestine into gastric stoma following resection of the stomach. *Chirurgie*, 23: 529–531, 1952.
12. Nogueira, P. Invaginacao retrograda jejuno-jejunal intra-gastrica postgastrectomia parcial. *Rev. cir. São Paulo*, 15: 80–88, 1949.
13. Puech, Leao, L. E. Invaginacao retrograda jejuno-gastrica atraves de boca de gastrectomia. *Rev. paulista med.*, 35: 105–108, 1949.
14. Steber, Von. *München. med. Wchnschr.*, 64: 648–652, 1917.
15. Vink, M. Retrograde intussusception of the efferent jejunal loop after gastrectomy. *Arch. chir. neerl.*, 2: 377–384, 1950.
16. Woelfler, A. Anterior gastro-enterostomy. *Zentralb. f. Chir.*, 65: 705, 1881.

The Use of Trypsin (Intramuscular) in the Treatment of Edema Due to Intestinal Anastomosis

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Experiences with crystalline trypsin in sesame oil* injected intramuscularly in the treatment of inflammation and edema associated with bruises, hematomas, sprains and fracture sites prompted us to evaluate its effect on the edema resulting from intestinal anastomosis. It seemed that this was a convenient way to study the effect of trypsin on wound healing under adverse conditions.

During the performance of end-to-end anastomosis of the intestine, the two rows of sutures used create a diaphragm. By inverting the intestine, serosa-to-serosa contact is secured. Edema results from the trauma of the passage of the needle, the manipulation of the intestinal wall and the tension of the suture material. It has been demonstrated [*1*] that finer, non-absorbable sutures cause less local reaction. However, no matter how careful and precise the surgical technic, the passage of the needle will tear small vessels and the pinpoint hematomas provide a nidus for local infection along the suture line.

Lichtman [*1*], in a study of the suture line following intestinal anastomosis in animals, observed that a marked exudation of leukocytes, erythrocytes and histiocytes occurs within a few hours. A network of fibrin is set down, sealing the line of anastomosis superficially. Unfortunately, the exudation does not stop at the point of maximal advantage, but continues with a progressive deleterious edema. The edema of the diaphragm and of the intestinal wall tends to reduce the lumen of the intestine to a point of obstruction. Excessive edema will tend to reduce an already marginal blood supply. Peritonitis or ileus further delay the onset of effective peristalsis. When peristaltic activity resumes, the progress of edema is halted.

* Parenzyme,® The National Drug Company, Philadelphia, Pa.

Materials and Procedure

Two groups of fifty-nine patients each, a control group and an experimental group, make up the series of this study. The types of operations performed in the experimental group are shown in Table 1.

Table 1

Types of Anastomoses in Fifty-Nine Cases Treated with Crystalline Trypsin in Sesame Oil Intramuscularly

Types of Anastomoses	No. of Patients
Gastric resection:	
Bilroth I	6
Bilroth II	16
Gastroenterostomy	1
Small intestine, end-to-end (adult)	10
Small intestine, end-to-end (newborn)	2
Ileotransverse colostomy	4
Colon:	
End-to-end colocolostomy	4
Closure, colostomy	2
Anterior resection, colorectostomy	14
Total	59

Immediately after operation involving anastomosis in the stomach, small intestine or colon, 5 mg. of crystalline trypsin in 1 cc. of sesame oil was given by deep intramuscular injection and repeated every eight hours for nine doses. Indwelling duodenal suction was maintained

until flatus was passed by rectum by patients in both groups. Fluids and electrolyte balance were maintained. When a proximal vent, such as a jejunostomy, ileostomy or colostomy, was provided the case was not included in this study.

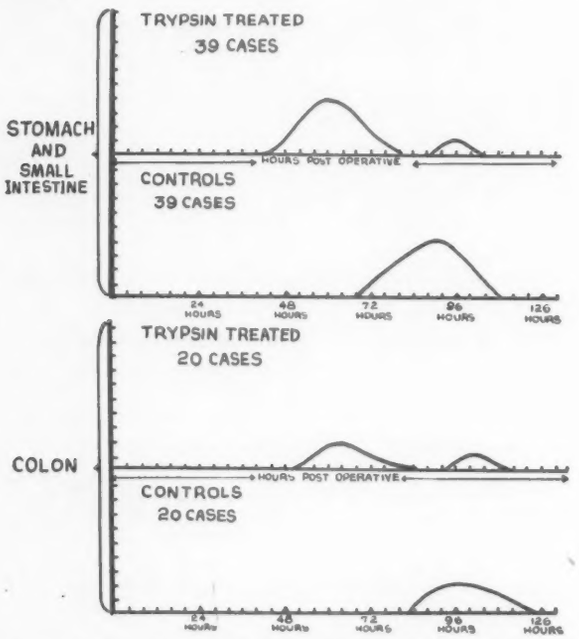

FIG. 1. Time of passage of gas rectally after performance of intestinal anastomosis in fifty-nine patients.

The patients were maintained on albumin by mouth beginning eighteen hours postoperatively with the duodenal tube clamped one hour following feeding. After the third or fourth day we started the patients on a concentrated intact protein preparation (vi-protinal) of high biologic value fortified with vitamins to supply the nutritional requirements.

To evaluate further the clinical effect of the trypsin preparation, three patients in whom malfunction of a gastroenterostomy stoma had developed were treated as mentioned previously. The duration of gastric retention was three, eight, and nine days, respectively, before treatment was started.

Trypsin therapy was used in ten patients with acute intestinal obstruction due to diverticulitis or carcinoma of the descending colon. When a tumor mass obstructs the colon, it is a sudden increase in the inflammatory edema that finally causes the obstruction. These patients were also under continuous indwelling suction and received 500 mg. tetracycline twice daily in their intravenous solutions.

RESULTS

Of the fifty-nine cases of intestinal anastomoses, fifty-five patients responded favorably. These passed gas in forty-eight to seventy-two hours, while four patients took eighty to ninety-six hours. These patients were more comfortable and had less distention than those in the control group. (Fig. 1.)

The control group of patients passed gas in seventy to 120 hours. These patients were much less comfortable and had greater distention than the experimental group.

The three patients with malfunction of the gastroenterostomy stoma secured release of retention within twenty-four hours of intramuscular trypsin therapy. A larger number of cases in this category was not available because of the decrease in incidence of this complication of gastric surgery.

The ten patients with acute intestinal obstruction were decompressed within fifty-four hours. We agree that these results are difficult to substantiate because present day treatment involving duodenal suction, readjustment of fluid and electrolyte balance and the use of antibiotics brings the majority of patients with acute intestinal obstruction to elective surgery. However, it was the consensus of those who observed these patients that the release of the obstruction occurred earlier than in similar cases under previous therapy.

COMMENTS

The mechanism of trypsin as a therapeutic agent continues to be an academic problem. Most of the concepts are based on surmise or conjecture. For example, Innerfield et al. [2] concluded that the effect of trypsin is to reestablish "metabolic continuity with the remainder of the organism . . . in areas of acute inflammation. The end result is rapid suppression and reversal of signs and symptoms of acute inflammation . . . From a therapeutic standpoint, trypsin plays a significant role in catalyzing enzymatic sequences that augment the best reaction to injury."

Martin et al. [3], on the other hand, suggest that the anti-inflammatory effect of trypsin is a direct local effect. The local effects, consisting of increased permeability of vessels, vasodilation and decreased viscosity of edema fluid, combine to facilitate local drainage in inflamed

areas and hasten reversal of the inflammatory phenomena.

Observations reported by Adamkiewicz et al. [4] reveal that trypsin does not inhibit the inflammation resulting from proteolysis of tissue induced by trypsin injection itself. However, the same trypsin has an antiphlogistic effect on another acute inflammation located somewhere else in the body. "Since this action," according to these investigators, "is extra-adrenal, it may be that either trypsin itself or some products of the local proteolysis travel to the second inflammatory focus where they inhibit the reaction. Or yet, they affect the chain of reaction regulating the formation of inflammatory edema."

Whatever the mechanisms involved, we are satisfied that crystalline trypsin in sesame oil given intramuscularly as described enhances the postoperative clinical course of the patient with intestinal anastomosis.

SUMMARY

Crystalline trypsin in sesame oil given intramuscularly to patients in whom intestinal anastomoses were performed produced an earlier resumption of effective intestinal peristalsis. It also seemed to be effective in releasing retention due to a malfunctioning gastroenterostomy stoma and in reducing the edema around lesions causing intestinal obstruction.

REFERENCES

1. Lichtman, A. L. and McDonald, L. R. Fecal fistula. *Surg., Gynec. & Obst.*, 78: 449, 1944.
2. Innerfield, I., Angrist, A. A. and Schwarz, A. W. Parenteral administration of trypsin: clinical effect in 538 patients. *J. A. M. A.*, 152: 597, 1953.
3. Martin, G. J., Brendel, R. and Beiler, J. M. Mechanism of the anti-inflammatory action of trypsin. *Am. J. Pharm.*, 127: 123, 1955.
4. Adamkiewicz, V. W., Rice, W. B. and McColl, J. D. The antiphlogistic effect of trypsin in normal and in adrenalectomized rats. *Canad. J. Biochem. & Physiol.*, 33: 332, 1955.

Emphysema of One Lung Associated with Atresia of the Contralateral Pulmonary Artery

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THE absence of one pulmonary artery in patients in whom the mediastinum remains in the midline presents no major diagnostic problem. The striking difference in the vascular markings on the two sides in the routine roentgenogram of the chest suggests the diagnosis. The purpose of this report is to present a case in which the absence of the right pulmonary artery resulted in marked emphysema of the left lung. An initial diagnosis of congenital hypertrophic emphysema almost led to operative intervention which would have been fatal to this patient.

FIG. 1. Roentgenogram showing marked emphysema of the left lung with the mediastinum shifted to the right side.

CASE REPORT

A. M., a nineteen month old Negro female, was admitted to Grady Memorial Hospital on June 12, 1956, with a respiratory infection associated with a rapid respiratory rate. At birth she had weighed 5¾ pounds and had seemed normal. At two months of age she had been seen in the Out-Patient Department with "wheezing." A roentgenogram of the chest at that time showed infiltration throughout the right lung; the left lung was clear. She was treated in the Clinic for bronchopneumonia for two days; but when there was no improvement and no evident response to treatment, hospitalization was advised. Except for her frequent respiratory infections, her past history, developmental history, family history and immunization history were not remarkable.

Physical examination on admission revealed a small, irritable, female baby in moderate respiratory distress, with clinical findings compatible with right bronchopneumonia. A grade 3 systolic murmur was heard in the second left intercostal space, and the point of maximal cardiac impulse was shifted to the right. The initial white blood cell count was 24,650 per cu. mm., with a shift to the left. The urinalysis was negative and the hemoglobin concentration was within normal limits. A roentgenogram (Fig. 1) and fluoroscopic examination demonstrated emphysema of the left lung with herniation of this lung to the opposite side. An electrocardiogram was interpreted as being

FIG. 2. Bronchogram demonstrating the "fanning out" of the left bronchi and compression of the right bronchi.

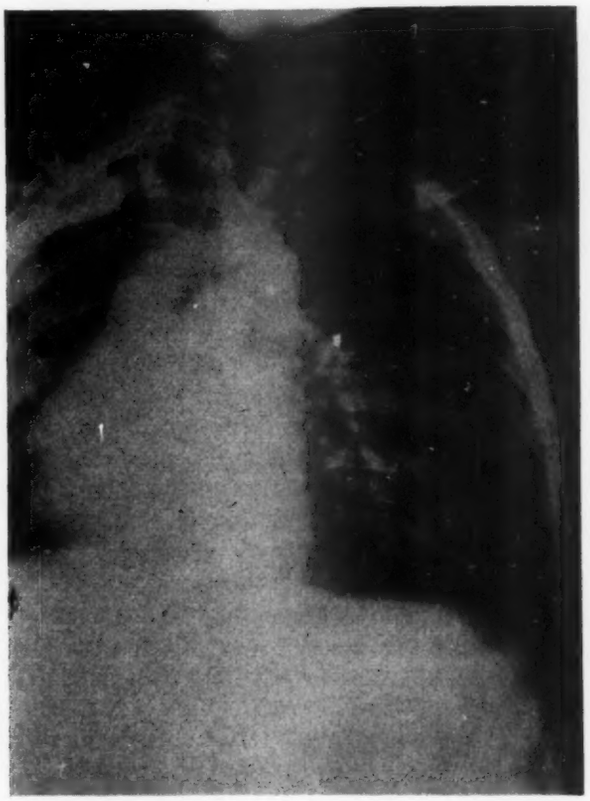

FIG. 3. Angiocardiogram showing good visualization of the left pulmonary artery and absence of the right pulmonary artery.

within normal limits. The patient was treated with penicillin, and within one week all clinical evidence of pneumonia cleared. A repeat roentgenogram one month after admission showed clearing of the infiltration with persistence of the unilateral emphysema. A bronchogram (Fig. 2) demonstrated a normal tracheobronchial tree, except for a "fanning out" of the bronchi on the left side.

Thoracotomy to relieve emphysema of the left lung was strongly considered. An angiocardiographic study prior to operation was elected in order to rule out the possibility of an atretic pulmonary artery to the right lung. The angiocardiogram (Fig. 3) clearly demonstrated the absence of the right pulmonary artery. The patient was discharged in good condition and is being followed up in the Clinic.

COMMENTS

Nadas and associates [9] reported on four patients with tetralogy of Fallot who had absence of one pulmonary artery. All their patients had atresia of the left pulmonary artery except one who also had dextrocardia. Miller [8] described a newborn infant with atresia of the right pulmonary artery and an otherwise normal heart who died on the sixth day of life after a pneumothorax had developed. At autopsy the right lung was found to be necrotic. In 1952 Madoff and co-workers [5] reported on one patient with unilateral pulmonary artery atresia and reviewed the literature back to 1850. In the case they reported, and in nine found in the earlier literature, there were associated anomalies of the heart or great vessels. Of the cases they reviewed, there was absence of the left pulmonary artery in three and of the right in six. In three patients the left lung was larger than the right, with herniation of the left upper lobe across the mediastinum. In all the cases they reviewed, an anomalous systemic arterial blood supply to the lung with the atretic pulmonary artery was described. Blalock [1] found an absence of one pulmonary artery in nine of 610 patients with tetralogy of Fallot. The reported frequent association of congenital heart disease with unilateral pulmonary atresia suggests that the loud systolic murmur present in our patient is on the basis of an undiagnosed congenital heart lesion.

The growth pattern and ultimate prognosis of these patients are unknown, but it is probable that the associated cardiac anomalies will largely determine longevity. As shown by Maier and Gould [6], an infant who undergoes pneumonectomy for pulmonary disease may develop normally. Horine [3] tied off one of the main branches of the pulmonary artery in dogs and found that necrosis did not occur unless the bronchial arteries were also ligated. Madoff and co-workers' [5] bronchospirometry studies in one patient with unilateral pulmonary artery atresia demonstrated that the lung with the atretic artery was responsible for 18 per cent of the oxygen uptake. They demonstrated further that 17 per cent (instead of the usual 1 per cent) of the left ventricular output entered the lung with the atretic artery.

Our patient, plus the three enumerated in the literature showing generalized emphysema, should certainly suggest the absence of one pulmonary artery in future patients presenting with generalized emphysema limited to one side of the chest. The diagnosis of unilateral pulmonary artery atresia associated with emphysema of the contralateral lung depends largely upon angiocardiography. It must be differentiated from localized hypertrophic emphysema, obstructive emphysema associated with a defect of the anterior mediastinum, congenital cystic disease of the lung and regional obstructive emphysema in infants and children. In all these the physical and roentgenologic findings are those of mediastinal shift and varying degrees of atelectasis. Cough and respiratory difficulty with episodes of cyanosis may be present in all these.

Localized hypertrophic emphysema is a well established clinical entity affecting a lobe or segment of lung by massive uniform overinflations of the alveolar sacs. The exact cause of this condition is not known in most instances, even upon close gross and microscopic examinations of specimens removed. Lewis and Potts [4] reported on a four month old patient who had obstructive emphysema of the right middle lobe associated with a large anterior mediastinal defect. Perhaps differentiations should be made between emphysematous blebs and intrapleural cysts. Pulmonary cysts are congenital in origin, have a definite fibrous tissue wall and are lined by epithelium. Emphysematous blebs are acquired and have either no specific lining or at most an alveolar type of flattened epithelium. Caffey [2] described regional obstructive pulmonary emphysema associated with respiratory infections in seven patients, and in all these patients the emphysema was a transient finding.

As yet no one has demonstrated an effective operation for the treatment of this anomaly. It is possible that patients with this condition who have difficulty resulting from a deficiency in the oxygenation of blood may be benefited by talc poudrage of the ischemic side.

SUMMARY

1. Marked emphysema of one lung associated with absence of the pulmonary artery to the opposite lung may erroneously direct attention toward the pulmonary changes.

2. Unilateral emphysema in an infant is quite suggestive of atresia of the contralateral pulmonary artery, after other causes of unilateral emphysema have been excluded.

3. The anomaly appears to be associated with the tetralogy of Fallot more often than any other isolated cardiac defect.

4. Most of the cases may be diagnosed by a routine x-ray of the chest, but in questionable cases, particularly those in which there is unilateral emphysema, angiocardiography may be necessary.

REFERENCES

1. Blalock, A. Surgical procedures employed and anatomical variation encountered in the treatment of congenital pulmonary stenosis. *Surg., Gynec. & Obst.*, 87: 385, 1948.
2. Caffey, J. Regional obstructive emphysema in infants and children. *Am. J. Dis. Child.*, 60: 596, 1940.
3. Horine, C. F. and Warner, C. L. Experimental occlusion of the pulmonary artery. *Surgery*, 28: 139, 1934.
4. Lewis, J. E. and Potts, W. J. Obstructive emphysema with a defect of the anterior mediastinum. *J. Thoracic Surgery*, 21: 438, 1951.
5. Madoff, I. M., Gaensler, E. A. and Strieder, J. W. Congenital absence of the right pulmonary artery. *New England J. Med.*, 247: 149, 1952.
6. Maier, H. C. and Gould, W. J. Agenesis of the lung with vascular compression of the tracheobronchial tree. *J. Pediat.*, 43: 38, 1953.
7. Mendez, F. L., Leahy, L. J. and Butsch, W. L. Some aspects of bronchiectasis in infants. *J. Thoracic Surgery*, 24: 50, 1952.
8. Miller, J. F. Congenital absence of the right pulmonary artery in a new-born. *Am. J. Dis. Child.*, 53: 1268, 1937.
9. Nadas, A. S., Rosenblum, H. O., Wittenborg, M. H. and Rudolph, A. M. Tetralogy of Fallot with unilateral pulmonary artery atresia. *Circulation*, 8: 328, 1953.

Torsion of the Spermatic Cord in Adult Scrotal Testes

A REVIEW OF EIGHTEEN CASES MANAGED SURGICALLY

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AT one time torsion of the spermatic cord was considered of sufficient rarity to warrant counting all recorded cases. Indeed, Hewitt and Gilmer [*1*] did this as late as 1951, when they found *515* instances in the literature and added six of their own. It was thought, too, that the catastrophe was especially infrequent in normally situated testes of the adult. Since then, however, it has become apparent that the lesion, while not encountered daily, is by no means an uncommon occurrence [*2–13*]. Moreover, the reviewer was struck by two facts: (1) the high rate with which testes were lost, and (2) the repeated instances in which recurring, spontaneously reduced torsions were mentioned [*2,5,6,13–15*]. Usually no definitive treatment had been given until one of the attacks terminated in acute strangulation and the testicle was lost. It became apparent that there were two varieties of torsion of the spermatic cord, namely, acute strangulation, and recurring, spontaneous reduction. If these were clinically distinguishable, then fixation or anchoring performed after an episode of spontaneous reduction should markedly improve the salvage rate for testicles in this disease.

Since January, 1954, it has been the policy of the Urologic Section, U. S. Army Hospital, Fort Sill, Oklahoma to anchor both testes as soon as the diagnosis of recurring, spontaneously reducing torsion has been made. Up to July 31, 1956, the entity had been encountered eight times in seven men. The purpose of this communication is to compare the results in these cases with a group of ten cases of acute strangulating torsion seen between January 1, 1951 and July 31, 1956. This does not include eight cases of acute strangulation, all treated before January 1, 1951, in which none of the involved testes was saved (the records were not available). Accordingly, I have treated surgically twenty-six cases of torsion of the spermatic cord; however, only eighteen cases were used in this analysis.

Acute, Strangulating Torsion of the Spermatic Cord. In the ten cases reviewed the lesion occurred on the right side twice and on the left eight times; four of the patients were Negroes, the rest Caucasians, and all were between the ages of twenty and twenty-eight. Three patients gave histories of recurring bouts of pain on the involved side strongly suggestive of spontaneously reducing torsions. Three of the men were awakened out of sleep by the pain, whereas one was getting out of bed and two were arising from a squatting position; four patients did not remember what they were doing. The pain was always dramatic in onset, agonizing in character, radiated into the lower abdomen, and was frequently accompanied with nausea and vomiting. It was followed shortly by the appearance of a hard, exquisitely tender, heavy scrotal mass; the testicle could not be differentiated from its adnexa, and the cord was markedly thickened and felt pulseless (an equivocal sign—the spermatic artery is often not palpable in a surgically exposed, but intact, physiologic cord). In two instances there was a suggestion of a twist to the spermatic cord.

Four patients were seen in less than twelve hours after the appearance of symptoms and all their testes proved viable at surgery and were saved. These cases have been followed up from six months to a year and no testis has

undergone atrophy. The other six patients had had symptoms for forty-eight hours or more when admitted; the testicles were gangrenous at surgery and were removed. When the affected testis was redeemable, both testes were anchored at the same procedure; if orchiectomy was performed, the second side was fixed ten days to two weeks later, to minimize possible spread of contamination. Thus, even after considerable experience with this pathologic entity, only four of ten testes were saved. Two of the three patients who gave histories suggestive of recurring torsions lost the affected testicle.

Recurring, Spontaneously Reducing Torsion of the Spermatic Cord. The recurring torsions occurred on the right side once (in a young white man of twenty-one who had lost his left testis four years earlier because of torsion), the left five times (two were associated with large varicoceles), and bilaterally once. Three of the patients were Negroes, the others Caucasians; the youngest patient was twenty-one years of age, the oldest twenty-six. Four of the patients had had several attacks of pain, all of which had been ignored; two others had just two attacks, while the Negro patient with bilateral disease had been hospitalized twice elsewhere for so-called epididymitis. These charts have been examined. In one instance, when the patient was first seen there was no swelling on either side and, indeed, all the acute pain was gone; on the second occasion the pain and swelling vanished as soon as the patient was put to bed, much to the surprise of his physician.

In all instances the onset of the attacks of recurring torsion was preceded by no unusual activity; in fact, the patients almost never recalled what they had been doing. The pain appeared abruptly, was rarely as violent as that of strangulation and usually disappeared as suddenly as it came, often aided by manipulation of the scrotum, as the following case will illustrate.

A twenty-three year old Negro corporal was originally seen in the Urologic Clinic, U. S. Army Hospital, Fort Sill, Oklahoma, on February 16, 1954, complaining of bouts of sudden, lancinating pain in the left scrotum. The pain was relieved by the patient's sitting down and "jiggling" the scrotum. Examination of the external genitalia disclosed nothing significant. Six days later, on February 22nd, he was admitted to the Urologic Ward at 8 A.M., doubled up in agony. He had been stricken by the pain in his left scrotum at breakfast. As I touched his scrotum, the left testicle jumped and unwound. Relief was great and instantaneous. Both testes were anchored the next morning and the patient has had no difficulties since.

Bilateral fixation was done in the six men with both testes; the seventh man had but one. In the two men with large varicoceles, inguinal ligations of the spermatic veins were carried out simultaneously. These men have been followed up anywhere from three months to more than two and a half years. They have had no further symptoms, none of the testes has atrophied and, of course, none has been lost.

COMMENTS

Presentation of the causes of torsion of the spermatic cord would be superfluous here. Almost everybody who has elected to write about the subject has discussed the etiology to some degree, but the papers by Muschat [*16*] and Lovell [*17*] are outstanding. The clinical picture presented here of both the acute strangulation and the recurring torsions agrees substantially with the descriptions of others. It should be mentioned, however, that strangulation is not always associated with pain. Underhill [*4*] presented such an instance in 1955, which resulted in loss of the right testicle.

In 1953 Smith [*10*] raised anew the issue of non-surgical reduction, recommending local anesthesia which he used successfully in two cases. The possibility that the torsions thus reduced might have done so unaided, particularly in the light of this study, must be considered. There is, however, another more serious objection to taxis. Everybody has emphasized the importance of prompt intervention, Weyeneth and Clerc [*3*] stating categorically that most testes undergo gangrene in six hours. While it was true that none of the four salvaged cases of acute strangulation in this series were operated upon in the first six hours (but all in less than twelve), and Klinger [*7*] has reported finding a viable testicle five days after the onset of symptoms, the importance of wasting no valuable time where strangulation is suspected must again be emphasized. Finally, and obviously, once the diagnosis of torsion, whether strangulating or

recurring, has been made, *surgical fixation becomes mandatory*. For a description of this exquisitely simple little procedure one is referred to either Deming and Clarke [*6*], or Lowsley and Kirwin's text [*14*]. The necessity for anchoring the fellow testicle has been amply proved statistically [*1*].

Torsions of the spermatic cord were most commonly confused with acute epididymitis, this confusion costing six men a testicle each. It may be of value to point out that twice I have mistaken hydroceles of the spermatic cord, incarcerated in the external inguinal ring, for torsions. At surgery it was apparent that continued pressure would have shortly produced gangrene.

SUMMARY

Ten cases of acute strangulating and eight of recurring, spontaneously reducing torsion of the spermatic cord in scrotal testes have been reviewed. Seventeen men were involved, all of whom were in the third decade of life; seven were Negroes and ten were Caucasians, a disproportion which may be significant. The right side was involved only four times, and the left side fourteen. In ten cases of acute strangulation only four testicles were saved, but in none of the eight cases of recurring torsion was a testicle lost. In fact, complete relief of symptoms was obtained after fixation. Atrophy did not occur in any of the testes anchored.

CONCLUSION

Surgical fixation of both testes is well merited after a diagnosis of recurring, spontaneously reducing torsion of the spermatic cord has been made.

REFERENCES

1. Hewitt, L. W. and Gilmer, E. S. Torsion of the spermatic cord: report of six cases. *Tr. Southeast. Sect. Am. Urol. A.*, 15: 119–127, 1951.
2. Wolfromm, M. G. Trois cas de torsion du testicule par volvulus de la glande dans la cavite de la sereuse vaginale, un chez un adulte de 57 ans, deux chez des sujets de 16 ans. *J. d'urol.*, 60: 563–567, 1954.
3. Weyeneth, R. and Clerc, R. Sur trois cas de torsion du testicule chez l'adulte. *J. d'urol.*, 58: 846–856, 1952.
4. Underhill, B. M. L. Torsion of the testicle. *Lancet*, pp. 129–130, 1955.
5. Rieser, C. Masses in the scrotum: problems in their diagnosis. *Southb. M. J.*, 48: 627–631, 1955.
6. Deming, C. L. and Clarke, B. G. Torsion of the spermatic cord. *J. A. M. A.*, 152: 521–522, 1953.
7. Klinger, M. E. Viable testicle five days after an unreduced torsion of the spermatic cord. *New York State J. Med.*, 54: 1951–1952, 1954.
8. Saave, J. J. A rare surgical emergency: torsion of the spermatic cord with fully descended testes. *M. J. Australia*, 2: 453–454, 1953.
9. Walton, A. J. Torsion of the testis and its appendix. *Lancet*, 2: 211–213, 1952.
10. Smith, G. I. Testicular torsion and acute epididymitis. *California Med.*, 78: 506–507, 1953.
11. Carson, R. B. Torsion of the spermatic cord. *Southb. M. J.*, 46: 909–911, 1953.
12. Wheeler, J. S. and Clark, F. B. Torsion of the spermatic cord. *New England J. M.*, 247: 973–977, 1952.
13. Frohbose, W. J. Torsion of the testicle. *Virginia M. Monthly*, 78: 250–254, 1951.
14. Lowsley, O. S. and Kirwin, T. J. Clinical Urology, 3rd ed., vol. 1, p. 196. Baltimore, 1956. Williams & Wilkins Co.
15. Ferguson, C. Torsion of testicle on epididymis. *Mil. Surgeon*, 94: 167–168, 1944.
16. Muschat, M. Pathological anatomy of testicular torsion; explanation of its mechanism. *Surg., Gynec. & Obst.*, 54: 758–763, 1932.
17. Lovell, S. H. Torsion of the testis and its appendages. *M. J. Australia*, 2: 787–790, 1950.

Immediate Replacement of Tissue Losses from Hand or Wrist by Means of Bipedicled Cross Arm Flaps

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Presented to the sectional meeting of the American College of Surgeons, held at Presbyterian Hospital, Philadelphia, Pennsylvania, on February 15, 1956.

IT has long been recognized that rapid, adequate skin coverage of exposed structures in the hand and wrist, thereby reducing the formation of scar tissue and the period of immobilization, is necessary to produce a good result in surgery of the hand and wrist.

In an extensive search of the literature, not too much could be found dealing with exactly this subject. Blair, Ivy and Gillies have used the arm and wrist to transport flaps to other parts of the body. Coakley [3] used direct forearm flaps to resurface soft tissue defects of the lower extremities. Horn [4] and others have used tissues of the hand to repair defects of the fingers. We have not been able to find a direct reference in which one arm has been used to supply tissue for the other arm, wrist or hand. This method certainly must have been used frequently by many surgeons, but if it has ever been described in the literature, we are not aware of it.

Bunnell [2], McDonald and Webster [1], Brown, Cannon and co-workers [5] have advocated the use of direct flaps from the abdomen or back for repair of these defects. It occurred to us that a more rapid and efficient method of transferring tissue to the hand and wrist is desirable and possible. Therefore a flap had to be of sufficient thickness to replace and duplicate the tissue of the hand and wrist well, and to make a permanent and serviceable repair. For a rapid shift, a bipedicled flap was necessary. The tissue of the abdomen and chest could be used, but either the flap obtained would contain too thick a layer of subcutaneous tissue or the position required to transfer the tissues to the hand or wrist would be too difficult to retain for the period of time necessary, and the postoperative care would be excessive. The inner and outer aspects of the thighs and the tissues of the back presented the same problems, although the tissue of the back was of a better thickness and therefore would make a more satisfactory all round repair. These positions would also require the continuous hospitalization of the patient. The advantages of using the tissues of the opposite arm are many. The tissue flap can be moved quickly; a complete repair can be made in two weeks by the use of a bipedicled flap. The tissue obtained will be of the proper thickness and amount, and the quality and texture will be the closest possible approximation to the destroyed tissue. Immobilization of the hand will have to be maintained only for one week; after that period, active and passive motion can be started. Healing of the tissues over the exposed tendons starts immediately when the flap is designed, raised and sewed into the hand or wrist at the first operation and has progressed two weeks when the repair is completed. The

position of the hands, wrists and arms is easy to maintain. The patient has one hand free and can walk around. He can be discharged from the hospital the second day after the first operation and be rehospitalized at the end of a week, discharged the second day after the second operation and rehospitalized at the end of that week, and discharged finally on the second day after the third operation. Physiotherapy can be started after the second operation and continued from that time. The patient can be dressed easily and, because his arms are enclosed in plaster, needs no special care other than daily wound dressings.

The use of the cross arm flap is indicated chiefly when tendons and other deep structures are exposed or there is an extensive loss of tissue. When the losses are of a more superficial nature, a split-thickness graft can perhaps be used. Although this method can also be used for losses of finger tissue, local flaps from the same or adjoining fingers should be considered first. Both volar and dorsal losses of the hand and wrist can be remedied by cross arm flaps. Bilateral defects in certain types of cases and in certain areas can be repaired simultaneously. Large amounts of suitable tissue can be supplied in this way.

The operative procedure is as follows: According to the position and size of the defect on the hand or wrist, a bipedicled flap is designed on the opposite arm, either above or below the elbow, volar or dorsal surface. This flap should be designed so that when it is freed the opposite hand can be passed under it until the defect is under the mid-portion of the flap; the flap can then be sewed into the corresponding edges of the defect without any tension. Small flaps can be raised from the remaining edge of the defect, and these are sewed to the raw surface of the flap to increase the area of attachment. The raw area caused by the raising of the flap is covered by a split-thickness skin graft first. The hand is then passed under the flap and the flap sewed in. As much of a pressure dressing as can be made is applied to the skin graft, care being taken not to embarrass the blood supply to the flap. Even though we have found it impossible to apply an effective pressure dressing to the skin graft, the percentage of take has been high. The plaster cast is then applied.

A plaster band is applied to each upper arm and these bands are then connected by a plaster bar extending from side to side. A hand and a wrist, or both wrists, as the case may be, are fastened together with plaster. The wounds are bandaged in the usual way. This method provides good retention, and both arms can be raised as a unit or the plaster bar can be allowed to rest on the anterior chest. One hand remains free. Care must be exercised to keep both pedicles free of tension while the plaster is being applied.

At the end of one week the lower pedicle of the flap is severed and the cut end is sewed into the corresponding end of the defect. We use No. ooo black silk for all skin sutures in this procedure. The cutting of the lower pedicle allows the arms more freedom even though the plaster retention remains unchanged. Physiotherapy can be started at this time. We have never had a case in which the blood supply of the flap was embarrassed by cutting of the first pedicle in one week's time. At the end of the second week after the patient is rehospitalized, the upper pedicle is severed and the cut end sewed into the other edge of the defect. There has been no instance of circulatory embarrassment in the flap after cutting the upper pedicle of the flap in two weeks. No revision is carried out when the ends of the flap are sewed into the edges of the defect. If revision is necessary for cosmetic reasons, it should be done at a later date, after complete return of function of the hand. Physiotherapy and motion can be continued immediately after this procedure.

CASE REPORTS

CASE 1. E. F., a twenty-four year old Negro man, was admitted to the accident ward at Graduate Hospital on May 9, 1955, after an automobile accident in which he had suffered extensive abrasions and complete avulsion of approximately half the skin of the back of the right hand, as well as other injuries. The extensor tendons of the second, third and fourth fingers, and the second and third metacarpal bones were exposed. The wound was cleansed thoroughly and débrided, and a bipedicled flap was designed on the opposite arm. The right hand was passed under the flap and the edges of the defect were sutured to the edges of the flap. The defect of the arm was closed with a split-thickness skin graft, and the arms were fixed in this position in plaster. One and a half weeks later the distal end of the flap was divided, and one week later the proximal end

FIG. 1. Case 1. Fresh injury to hand.

FIG. 3. Case 1. Reconstructed dorsum of hand thirty-four days after injury. Function of hand is normal.

FIG. 5. Case II. Reconstructed area twenty-six days after start of reconstruction.

was divided and the ends sutured in, completely closing the defect. Movement of the fingers was encouraged from the first week, and complete coverage was accomplished in two and a half weeks with no loss of function.

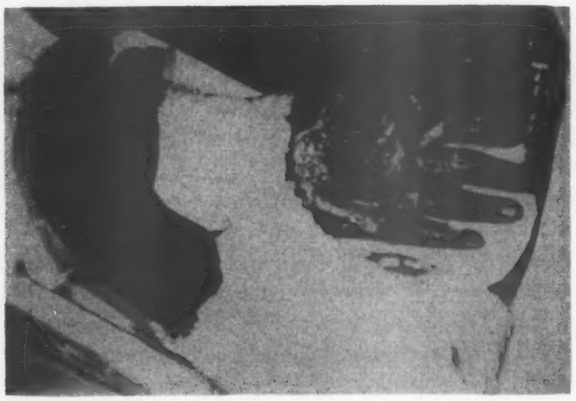

FIG. 2. Case 1. Bipedicled flap of the upper arm sewed into defect of the hand, and distal pedicle already severed.

FIG. 4. Case II. Gangrenous area of the right wrist.

Secondary revision of the flap was done at a later date. (Figs. 1 to 3.)

CASE II. D. F. was injured in an automobile accident on October 14, 1955, sustaining fractures and soft tissue injury on the right wrist. He was treated elsewhere primarily, and on November 20th he was referred to the staff orthopedist, who requested a plastic surgery consultation. At that time there was a large (2 by 3 inch) gangrenous area on the volar aspect of the wrist. The hand and wrist were swollen and the finger movements were very slight. The radial nerve appeared undamaged, but the ulnar and median nerves appeared to be involved. (Fig. 4.)

On November 25th a bipedicled flap was designed on the left forearm and applied to the

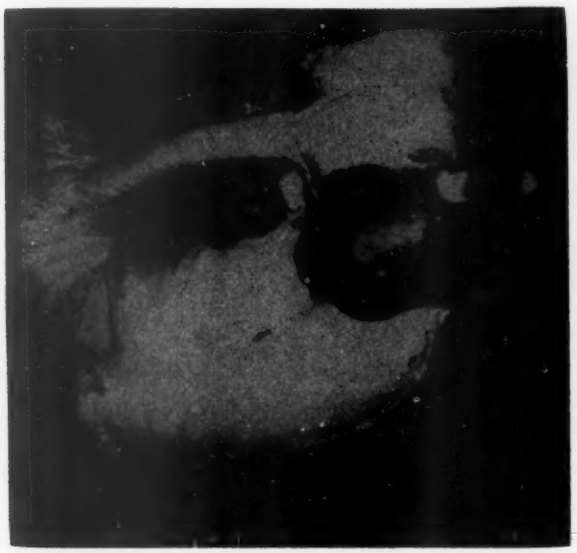

FIG. 6. Case III. Typical use of the bipedicled flap of the upper arm in the repair of defects of the dorsum of the hand and wrist.

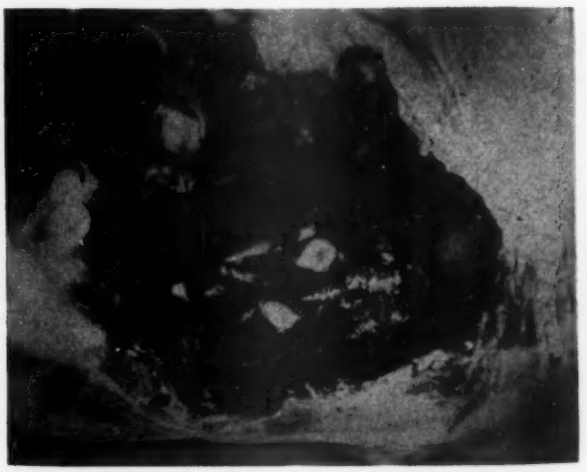

FIG. 7. Case IV. Use of volar–lower arm bipedicled flap for repair of defects of the volar finger and palm.

right wrist after excision of the gangrenous area. On December 1st the distal pedicle was divided and the patient was discharged from the hospital. Physiotherapy for the right hand was begun. On December 14th the proximal pedicle was divided and the ends of the flap were sutured into place. The flap was satisfactory and furnished an excellent cover for the defect of the wrist. (Fig. 5.)

The bipedicled flap was utilized in two additional cases, which will not be discussed in detail herein. One patient had defects of the dorsum of the hand and wrist (Case III, Fig. 6) and the other patient had defects of the volar surface of the finger and palm (Case IV, Fig. 7).

SUMMARY

A simple method for the resurfacing of defects of the hand or wrist is described. This method is simple and efficient, and gives uniformly good results. Its chief advantage is the rapid resurfacing of these defects, thereby improving the function of the hand and wrist. The amount of scar tissue formed and the length of time of immobilization are markedly reduced. This method is of distinct advantage in the primary or immediate treatment of injuries to the hand and wrist.

REFERENCES

1. McDONALD, J. J. and WEBSTER, J. P. Early covering of extensive traumatic deformities of the hand and foot. *Plast. & Reconstruct. Surg.*, 1: 49, 1946.
2. BUNNELL, S. Plastic problems in the hand. *Plast. & Reconstruct. Surg.*, 1: 265, 1946.
3. COAKLEY, W. A. Use of direct forearm flaps in resurfacing defects of the soft tissues of the lower extremities. *Plast. & Reconstruct. Surg.*, 6: 413, 1950.
4. HORN, J. S. The use of full thickness hand skin flaps in the reconstruction of injured fingers. *Plast. & Reconstruct. Surg.*, 7: 463, 1951.
5. BROWN, J. B. et al. Direct flap repair of defects of the arm and hand. *Ann. Surg.*, 122: 706, 1945.
6. NEWMAN, C. G. and VON WEDEL, J. The immediate attachment of double pedicled tube flaps to the carrier (wrist). *Plast. & Reconstruct. Surg.*, 11: 169, 1953.

Relief of Ascites with or without Anasarca, a New Procedure

PRELIMINARY REPORT

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RECURRENT ascites for a varying number of years has been treated within several general categories, as follows: (1) Treatment by medical methods; too well known to be discussed here. (2) Abdominal paracentesis; also too well known to be discussed here. (3) The Talma-Morison operation, in which the abdomen is opened, the liver, spleen and parietal peritoneum roughened, and the roughened omentum sutured to the parietal peritoneum with the intent of forming adhesions and establishing a new collateral circulation and drainage. (4) The Kamie-Crosby button, in which a plastic or glass funnel type of drain is sutured into the peritoneal cavity with the intent of draining ascitic fluid into the subcutaneous tissue (fat) and establishing an absorptive process to prevent further accumulation of ascitic fluid within the peritoneal cavity. (5) The Babcock procedure, in which the saphenous vein is utilized to funnel ascitic fluid from the peritoneal cavity into the venous circulation.

Whether ascites is due to cirrhotic, malignant, renal or definitely undetermined causes, treatment by any of the existing means has been mostly unsatisfactory. There would be nothing gained by discussing the end results percentagewise, but certain objections are clearly indicated for presentation.

The Talma-Morison procedure has been unsatisfactory in about 60 per cent of reported cases, and the total cannot be estimated because of the numerous cases, handled afterward by the general practitioner, that have not been reported.

The Kamie-Crosby button has been generally unsatisfactory in different ways. Often the omentum has promptly sealed off the invading button, causing obstruction of the basket portion and recurrent ascites. Also, there has been a recurrence of the ascites with edema and cystic formation in the omentum and peritoneum in some cases. In other cases this has occurred with the objectionable condition in which the drainage from the funnel end has water-logged the tissues and benefit ceases, resulting in mandatory drainage of these areas, usually in the vicinity of the funnel end.

The Babcock saphenous vein method also has been unsatisfactory.

In brief, the unsatisfactory results so far outweigh the satisfactory results that a different trend of thought and procedure seems to be indicated.

With this in mind, a tube (Figs. 1 and 2) was designed to be placed in the anterior abdominal wall, the purpose being that drainage of ascitic fluid from the peritoneal cavity could be accomplished as often as indicated without resorting to repeated abdominal paracentesis. This tube is of the best crystal clear acrylic plastic to permit cold sterilization with zephiran.®

CASE REPORT

F. C., a sixty-three year old white married woman, complained chiefly of enlargement of the abdomen with stiffness, swelling and weeping of the lower extremities, shortness of breath and scanty urinary output. These symptoms had existed for about two years and had become progressively worse. In the three months prior to operation, five abdominal paracenteses had been performed, with recovery of from 7,000 to 15,000 cc. of ascitic fluid.

The patient acknowledged three miscarriages during the early years of her marriage and had been treated for syphilis at different

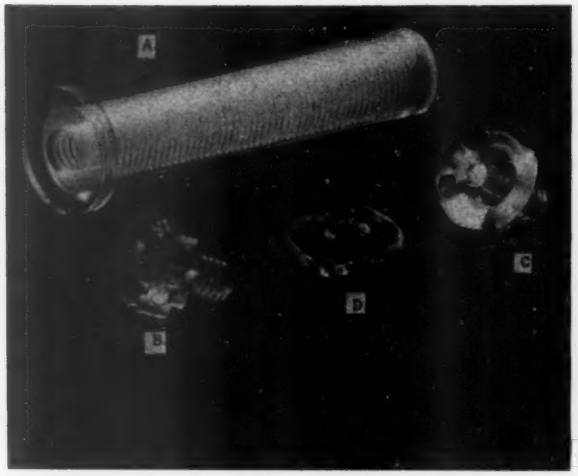

FIG. 1. A, conducting tube, to be sawed to proper length; B, sealing cap; C, peritoneal cavity collecting head; D, lock washer.

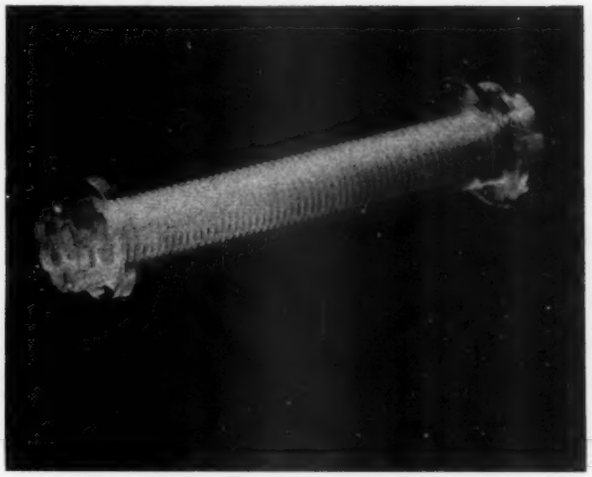

FIG. 2. Photograph of assembled tube.

times during the twenty-five years prior to her present illness. Treatment by different medical routines for ascites and anasarca for the previous two years were without lasting success. There was no history of smoking or the partaking of alcoholic beverages.

The pertinent findings on admission to the hospital were a systolic murmur heard at all areas, an abdomen distended with free fluid, advanced anasarca and marked torpidity. There was also a suppression of urine, 125 cc. being obtained by catheter in a twenty-four-hour period.

Laboratory findings were as follows: The urine was yellow and acid in reaction; it contained albumin, acetone and diacetic acid. The specific gravity was 1.017. There were 2 to 10 leukocytes per high power field. Casts (amorphous), bacteria and calcium oxalate crystals were present.

The blood Wassermann, Kolmer and cardiolipin tests were probably positive. VDRL was positive.

Examination of the blood revealed: hemoglobin, 10.3 gm. per cent (66 per cent); erythrocytes, 3,300,000; leukocytes, 3,700 per cu. mm.; polymorphonuclear leukocytes, 62 per cent; lymphocytes, 32 per cent; eosinophils, 5 per cent; monocytes, 7 per cent; stab forms, 7 per cent; segmented forms, 55 per cent. Blood urea nitrogen was 11 mg. per cent; creatinine, 0.6 mg. per cent; blood sugar (fasting), 110 mg. per cent.

Electrocardiogram indicated myocardial damage suggestive of coronary sclerosis. The blood pressure ranged from 206/90 to 150/70, and the weight ranged from 222 pounds the morning of operation to 170 pounds six days after operation.

The patient was operated upon on September 6, 1956. Using a routine preoperative preparation and under combined spinal and pentothal® sodium anesthesia, the abdomen was opened in the midline above the umbilicus, down to the edematous peritoneum, for about 4 inches. The boggy peritoneum was picked up by hemostats and incised only enough to insert a fenestrated suction tip. The hemostats were crossed during aspiration to prevent escape of too much ascitic fluid for two reasons, i.e., gradual decompression and more accurate measurement of the amount. After all the obtainable fluid was aspirated, the peritoneum was opened for its full incisional length and the abdominal contents were inspected. The liver was involved by the classical "hobnail" cirrhosis. Next the soggy, water-logged omentum was delivered outside the abdomen; about half of it was clamped off and amputated in 1 inch bites. After ligation of the remnant edge the parietal peritoneum (only) was roughened and the omental remnant was sutured to the parietal peritoneum in the same manner as in the Talma procedure.

This opening was covered with hot towels and a second incision was made in the midline, about 2 inches in length. The mid-point of this incision was located mid-way between the umbilicus and the superior border of the catheterized, empty bladder. The superficial tissues were carefully dissected away from the

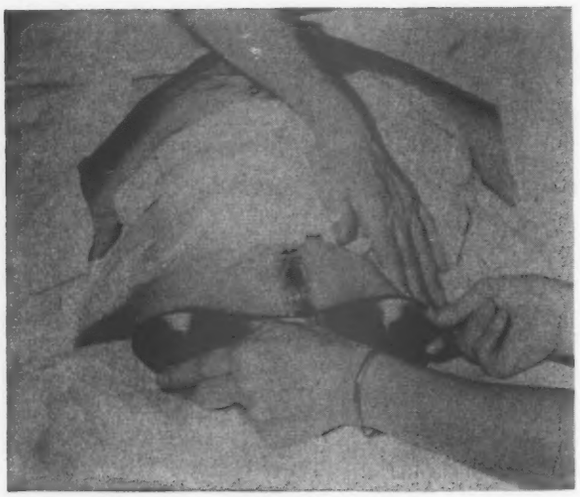

FIG. 3. Drainage of ascitic fluid by removal of sealing cap.

posterior fascia and cleared for about 1 inch to each side of the midline. The peritoneal cavity collecting head (Fig. 1C) was threaded through its lumen and head with fine surgical wire which was clamped to the tip of a curved hemostat and wound several times to prevent loss in the abdominal cavity in the event that it slipped loose from the operator's hand. The curved hemostat carrying the clamped wire was thrust, by way of the upper incision, from inside the peritoneal cavity outward at the mid-point of the lower incision, through the peritoneum and posterior fascia layer. Here the wire was unwound, clamped to another hemostat and pulled gently through the punched aperture, guarded within the peritoneal cavity by the hand of the operator, until the flat surface of the collecting head was flush with the parietal peritoneal surface. With the collecting head held in place by the wire and the hand of the operator within the peritoneal cavity, the assistant threaded the concave-convex lock washer (Fig. 1D) on the stem of the collecting head. When the collecting head was firmly but not too tightly fixed to the fascia by the lock washer, the guide wire was removed. Wire sutures were then placed to attach the lock washer to the fascia and thus prevent turning of the head. The conducting portion of the tube (Fig. 1A) was measured from the skin surface of the shoulder of the conducting tube to the lock washer and sawed to the proper length. It was then threaded on the shaft of the collecting head, thus assembling the entire tube in place. (Fig. 3.)

Both incisions were then closed layer by layer. A 15 cc. solution of penicillin and streptomycin was syringed into the tube. The sealing head (Fig. 1B) was then screwed in place. In the lower incision around the tube area, wire sutures were used because of the bogginess of the tissues. Separate dressings were applied to both incisions.

Postoperatively the course was as follows: On the first postoperative day the patient was given amigen,® dextrose 5 per cent and saline to 3,000 cc. intravenously with the idea in mind that the amigen and dextrose-saline solution would help replace some of the protein, sugar and chloride losses from the ascitic fluid. Also, this 3,000 cc. of fluids was given with the hope that the increase in fluids intravenously might aid in reducing the toxemia and promote refunctioning of the excretory faculties of the kidneys. This was what seemingly happened. For the first twelve hours postoperatively only 125 cc. were catheterized from the bladder. Beginning after twelve hours the patient started to urinate until the anticipated polyuric phase developed, and she urinated as often as every hour. She refused further intravenous therapy after the first day. The total urinary output could not be measured since the patient insisted that she would use only the toilet. About the second day mild postoperative distention, nausea and vomiting occurred which was relieved by a low saline enema, rectal tube, prostigmine and Wangensteen suction. This was removed the following day, and fluids and food were given by mouth.

About the third postoperative day the sealing cap was unthreaded under sterile conditions and about 3,400 cc. ascitic fluid were drained. (Fig. 3.) The tube was resealed. Two days later 2,400 cc. were removed and two days later 2,000 cc. Five days later 3,000 cc. were removed. The patient had become clear mentally, the tongue was moist and most of the anasarca had disappeared. The weeping through the skin of the lower extremities was gone, as was the marked pitting edema. There was still some edema about the upper thigh which disappeared a few days later. The appetite returned and the intestinal tract was functioning well. At this point it is well to note that the ascitic fluid was typical, and during the anasarcous phase a clear, watery fluid entirely different from the ascitic fluid drained around the outside of the tube. This was not

ascitic fluid seepage but the fluid of tissue edema, which ceased when the tissue edema subsided. The patient was up in a wheelchair and ambulatory about the fourth postoperative day, whereas previously she had been apathetic and unable to stand or sit because of the very marked anasarca, to the point that even her facial features had been so swollen that she had been unrecognizable as the same person.

The sutures were removed on the seventh day and the patient was discharged for home medical care. She was instructed not to touch the tube cap under any condition and that necessary drainage would be afforded at home under antiseptic conditions.

SUMMARY

1. An acrylic plastic tube has been designed for the palliative treatment of ascites and ascites with anasarca.

2. The ascitic fluid can be drained off gradually without the necessity of repeated abdominal paracenteses.

3. The tube can be sealed between drainages or attached to a vinyl plastic tube by means of a threaded adapter and collected at the bedside under continuous or controlled drainage.

4. There is little or no danger of peritonitis with antibiotics and proper care.

5. Pressure in the peritoneal cavity seems in some cases to have an effect on kidney function and tissue fluid osmosis.

6. Kidney function apparently can be restored to some extent by relief of the intraperitoneal pressure and instigated by intravenous fluids immediately following operation.

7. Partial or complete omentectomy can be used to advantage, in that the omentum is prevented from "fingering off" the foreign body.

8. The omentum, covered as it is with peritoneum, may have reversible secretory and absorptive function, possibly by osmosis.

9. Intravenous fluids can be used to replace losses of protein, etc., in this procedure.

10. The end results of this procedure are dramatic, quick and revealing. It is hoped that other workers will consider the use of this procedure. Further, more complete reports will be forthcoming as the number of cases increases and there is an exchange of ideas and findings.

Gas Gangrene of the Abdominal Wall Following Appendectomy

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WHEN one considers that the natural habitat of the clostridia is the intestinal tract of higher animals and man, it is difficult to understand why gas gangrene of the abdominal wall is not more commonly seen following surgery on the colon and small bowel. Fortunately it is a very rare complication in surgery but, as emphasized by Smith and Zimring [1], the acute, fulminating, toxic type of gangrene, if not recognized early, usually proves fatal. In a review of the literature from 1925 to 1944 by Cappiello and co-workers [2], only twenty-four cases of gas gangrene infection of the abdomen following appendectomy are recorded. By far the greatest number of cases of gas bacillus infection of the abdomen have followed appendectomies; however, it is known that occasionally this complication may follow gastric resections, herniorrhaphies, cholecystectomies and enterostomies. It has been stated by Shearer [3] that the vast majority of infections are the result of the presence of the organisms in the pathologic process or due to their presence in the intestinal tract. He does not believe that they are due to contamination from without as are those following war wounds.

Of the clostridia, approximately twenty-five species are saprophytic; one causes tetanus (Cl. tetani), one botulism (Cl. botulinum), and five or six species are responsible for gas gangrene. Another eight or ten species are frequently associated with wound infections. All species of clostridia are relatively large, gram-positive bacilli, although occasionally gram-negative forms are found in older cultures. By definition, clostridia produce spores, but some such as Cl. perfringens (welchii) rarely sporulate while most others sporulate freely. The first report of a known case of gas gangrene was that by Fabricus Mildanus in 1607. At that time the disease was a rarity, but following the Napoleonic wars gas gangrene of the extremities became a common disease of the wounded. In 1877 Pasteur and Joubert isolated an organism from putrid sheep blood which they labelled vibrion septique. This organism is now called Clostridium septicum. At the present time the following species of clostridia are regarded as the primary cause of gas gangrene: Cl. perfringens, Cl. novyi, Cl. septicum, Cl. bifermentans and Cl. histolyticum. In approximately 40 per cent of cases only one of these organisms is present and a mixed infection exists in 60 per cent of cases. Cl. perfringens is found in about 60 per cent of cases of gas gangrene wounds and is the most common of the clostridial organisms.

Approximately 90 per cent of vermiform appendixes can be shown to contain Cl. perfringens; and if the appendix is inflamed, the organism can be recovered from the muscular wall as well as the appendiceal lumen. In one case reported by Taylor [4] a patient who had undergone a right hemicolectomy suffered a very high fever and clinical gas gangrene of the anterior abdominal wall postoperatively. The bacteriologic examination could not confirm the original impression of clostridial infection; however, a hemolytic gas-producing streptococcus was isolated. In a case reported by Vier [5] the

author describes progressive postoperative gangrene of an appendectomy incision. When the wound exudate was cultured, Bacillus coli and Bacillus proteus grew out but there was no evidence of clostridia. This lesion was widely excised and treated locally with zinc peroxide, which resulted in healing.

Most authors are in agreement that prompt recognition of abdominal gas gangrene and aggressive treatment are essential if any success is to be realized. The following case is reported because it represents the rather typical findings one encounters and, in addition, presents several unique features which were encountered during the diagnosis and treatment.

CASE REPORT

A. E. O., a sixty-six year old white man, was admitted to the Veterans Administration Hospital, Lincoln, Nebraska, on January 9, 1956, with the complaint of abdominal pain of eight hours' duration. In the afternoon of the day prior to admission the patient had felt pain across the lower part of the abdomen, and later in the evening he had become nauseated. This patient had previously been treated for perforated duodenal ulcer; and because the pain was of similar nature, he sought hospitalization in the belief that he had a repetition of his previous disease. On physical examination the temperature was 102°F., pulse 96 and blood pressure 140/88. Examination of the abdomen revealed marked muscle-guarding throughout the abdomen and particularly in the right lower quadrant. There was pain on deep palpation, and rebound tenderness was referred to McBurney's point. A complete blood count showed a relatively normal red blood series, but the white blood count was 22,000 per cu. mm., with 87 per cent neutrophils. Urinalysis was essentially within normal limits. A film of the chest was negative and an abdominal x-ray film failed to show air under the diaphragm or evidence of small bowel obstruction.

Shortly after admission the patient was taken to surgery, and under general anesthesia an appendectomy was performed. There was considerable cloudy fluid in the peritoneal cavity, a sample of which was taken for culture. Postoperatively the patient did well, with the exception of a persisting low grade temperature which never exceeded 99.6°F. Culture of the peritoneal exudate revealed one colony of gamma streptococci. The histopathologic diagnosis on the submitted vermiform appendix was acute suppurative appendicitis. On January 17th, after an essentially uncomplicated course, the patient began to complain of cramping abdominal pains and abdominal distention. At this time the McBurney incision was healing satisfactorily. An x-ray film of the abdomen showed a stepladder appearance suggestive of small bowel obstruction. A Miller-Abbott tube was inserted and suction started, but the obstruction persisted. Therefore on January 18th the patient was returned to surgery and, through a right paramedian incision, the peritoneal cavity was explored. A closed loop obstruction due to adhesions was encountered in the lower ileum, and a further obstruction was present which was due to an adherent loop of small bowel attached to the sigmoid colon. Lysis of these adhesions was performed and the abdomen closed.

The patient was maintained satisfactorily on parenteral fluids, and on the second postoperative day bowel tones were active. However, abdominal distention persisted despite nasogastric suction. On January 22nd, examination of the incision revealed a foul, malodorous drainage exuding from the abdominal wound. An x-ray film of the abdomen again showed the stepladder appearance which was previously noted. Again the patient was returned to surgery and, on removal of the skin sutures, a subcutaneous abscess was present which had progressed on into the belly of the rectus abdominis muscle and adjacent structures. The tissue was of a gray color, very necrotic, and there was a suggestion of crepitation. All the involved tissue was débrided before the peritoneal cavity was entered. Specimens were taken for smear and culture. Within the peritoneal cavity it was noted that the sigmoid colon was bound down and doubled over against a pelvic abscess. This obstruction was cleared and the abscess was drained through a separate stab incision. The small bowel was not involved in the obstructive process at this time. The abdomen was closed and the patient was returned to his room in satisfactory condition.

Because of the presence of the purulent fluid noted at the first operation, the patient had been given a course of penicillin, 600,000 units twice daily, and streptomycin, 1 gm. twice daily, for a period of seven days. Again, following the second operation, the patient was main-

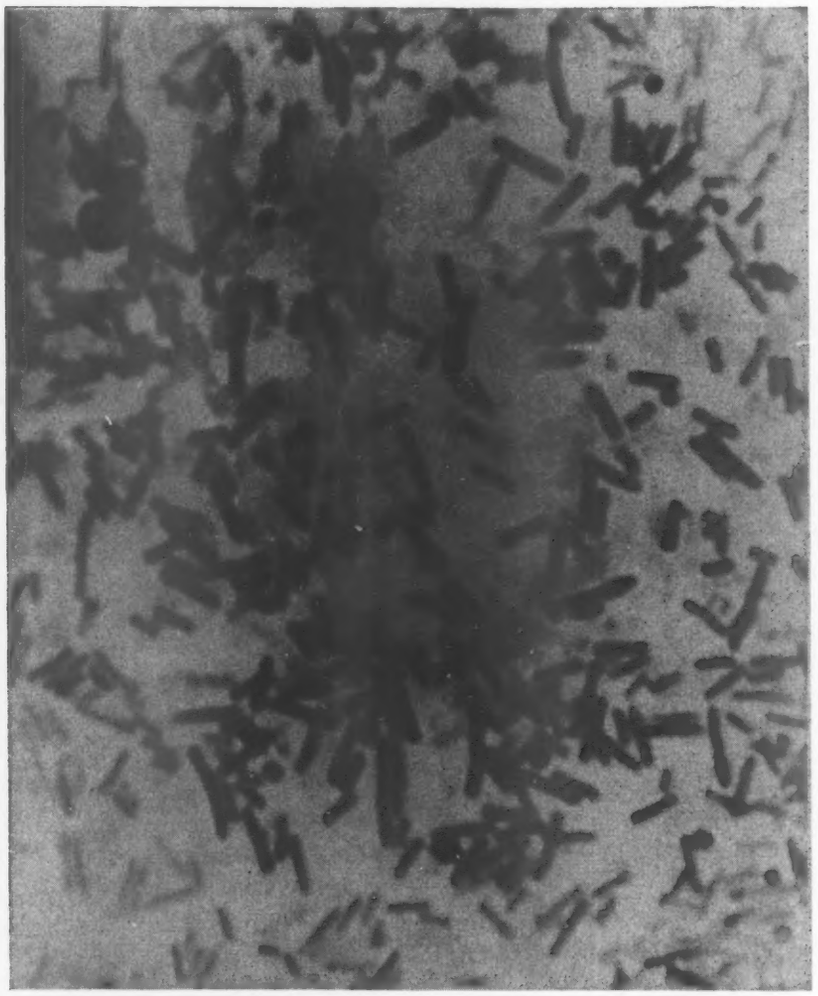

FIG. 1. Photomicrograph of the gas gangrene bacillus culture showing the terminal, subterminal and free spores.

tained on the same regimen of penicillin and streptomycin. Following the third procedure this treatment was continued and, in addition, tetracycline was administered parenterally. Two small Dakin catheters were left within the subcutaneous tissue and these were irrigated daily with tetracycline in solution. A smear of the exudate showed numerous gram-positive bacilli (Fig. 1) containing subterminal spores, and some gamma streptococci also were identified. On thioglycollate media the gram-positive bacilli were again identified as well as Escherichia coli and gamma streptococci. In this media it was noted that gas formers were present. On the basis of these findings the diagnosis of gas gangrene of the abdominal wall was made and a skin test was done in preparation for administration of the antitoxin. The antitoxin was of the polyvalent globulin modified type containing 10,000 units of Cl. welchii antitoxin, 10,000 units of Cl. septicum, 3,000 units of Cl. histolyticum, 1,500 units of Cl. novyi and 1,500 units of Cl. oedematiens. Skin testing with this preparation revealed moderate reaction; therefore the patient was desensitized by slow intravenous administration of a very dilute saline solution of antitoxin. No reaction was observed to this administration, so during the next twenty-four-hour period a total of twenty vials of polyvalent antitoxin containing 520,000 units was administered.

The following day the patients' temperature rose to 103°F., and thereafter slowly returned to normal ranges where it remained. At this time, bacteriologic studies revealed the organisms to be particularly sensitive to furadantin;® therefore this was administered orally and furadantin solution was used to irrigate the

Dakin catheters within the incision. The bacteriology department continued to attempt identification of the gram-positive sporulating bacilli, but after the initial positive thioglycollate culture the organism failed to grow on further culture attempts. It was thought that this characteristic was due to the attenuation of the strain undoubtedly as a result of the heavy antibiotic concentration which was present. For this reason definitive identification was impossible. Inasmuch as Cl. perfringens rarely sporulates and because its gas production is in somewhat greater amounts than was encountered during the culture of the organisms under discussion, it seemed likely that this organism was not present.

COMMENT

Those who have written on the subject of gas gangrene of the abdominal wall following surgery have commented on the marked toxicity and high fatality which accompanies this rare complication. The patient reported on by Shearer [3] died forty-four hours after operation, and the patient reported on by Smith and Zimring [1] died on the fifth postoperative day. The patient described by Cappiello and coworkers [2] died on the seventh postoperative day despite intensive treatment with penicillin, streptomycin and gas bacillus antitoxin. It is believed that the successful outcome of the case presented herein was due to the intensive administration of antibiotics postoperatively, as well as of the use of antitoxin when the diagnosis of gas gangrene was suspected.

The presumptive diagnosis was established on the basis of the gross appearance of the infected wound. When the wound exudate was found to contain gram-positive bacilli with subterminal spores which were gas producing in thioglycollate media, this impression was strengthened.

SUMMARY

A case of gas gangrene of the abdominal wall following surgery is presented. A therapeutic program is outlined which includes the use of gas gangrene antitoxin, antibiotics and surgical treatment with wide excision and débridement of involved tissue.

Acknowledgment: The authors are indebted to Robert A. Patterson and Richard D. Ferguson for technical aid.

REFERENCES

1. Smith, P. E. and Zimring, J. G. Gas gangrene of the abdominal wall following ruptured gangrenous appendicitis. *Am. J. Surg.*, 45: 351–352, 1949.
2. Cappiello, W. A., Liccese, E. and Crecca, W. D. Gas bacillus infection of the abdomen following appendectomy. *J. M. Soc. New Jersey*, 47: 519–520, 1950.
3. Shearer, J. P. Gas gangrene of the abdominal wall following gangrenous appendicitis. *Ann. Surg.*, 90: 114–117, 1929.
4. Taylor, J. W. Gas gangrene: report of an unusual case with a therapeutic program for gas gangrene. *Am. J. Surg.*, 87: 869–873, 1954.
5. Vier, J. H. Progressive postoperative gangrene of the abdominal wall. *Surgery*, 7: 334–341, 1940.

Splenectomy in Sarcoidosis

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IN 1948 the National Research Council defined the disease sarcoidosis as a disease of unknown etiology with pathologic changes similar to those seen in tuberculosis. The condition may involve almost any part of the body but is more commonly observed in the lungs or in the cervical lymph glands.

X-rays of the chest show typical changes in the lung fields, such as symmetrically enlarged hilar lymph nodes, soft peripheral infiltration and miliary foci, often confluent or nodular lesions or fibrotic scars in late stages. The intracutaneous tuberculin test is invariably negative.

Epithelioid cell tubercles with calcified bodies in giant cells are seen on examination of biopsy specimens of lymph gland and skin.

The Nickerson-Kveim test of an intracutaneous injection of a preparation of human tissue obtained from a sarcoid lesion results in a reaction similar to that of the tuberculin test after Mantoux.

The disease runs a chronic and unpredictable course. Spontaneous remissions occur, and in two of the cases involving the cervical glands that I have observed the patients now have remained well for ten years or more. The prognosis in the pulmonary type is less favorable, and death may result from fibrosis and subsequent respiratory and cardiac involvement.

Until the advent of cortisone and ACTH, treatment was largely symptomatic. However, these drugs have now been proved to be of limited assistance.

Rippmann [*12*] stated that the chief value of cortisone and ACTH is (1) to carry a patient through an active stage to a spontaneous remission, (2) to speed up the process of scarring of the sarcoid lesions, and (3) to give the patient a subjective feeling of well-being and to relieve him from harassing symptoms. This author also stressed the importance of psychotherapy because of the chronicity of the disease, in giving the patient assurance through the long period of illness.

The spleen, along with the liver, is said to be second only to lymph nodes and lungs in frequency of involvement by this disease. Several instances with and without splenomegaly were discovered only after splenectomy and histologic examination of the spleen in patients in whom the disease was unsuspected preoperatively.

It is generally agreed by those who have used cortisone and ACTH in sarcoidosis that these drugs hasten the healing of the sarcoid lesions as shown histologically by the increase in fibrosis and hyalinization and by the decrease in size and number of the tubercles.

Ray [*10*] gave cortisone to three patients because of splenomegaly. In two of these cases hypersplenism was present; one patient responded well to steroid therapy, but in the other case splenectomy was necessary. The third patient received the drug because of a greatly enlarged spleen. In this case the spleen decreased in size approximately one-third on therapy.

Miller and Bass [*9*] and Shulman et al. [*13*] noted a favorable response to the use of cortisone and ACTH in sarcoidosis, not only in the pulmonary and eye lesions but also in the size of the peripheral lymph nodes and spleen.

In seven of the nine cases in which the spleen was enlarged, a decrease in size following the use of ACTH was noted by Shulman et al. The decrease in size was observed as early as the second day following therapy. In seven cases the spleen could not be palpated after this treatment.

In 1944 Friedman [*3*] reported a case of sarcoid splenomegaly with autopsy, and in 1950 Kay [*4b*] reported four cases of this condition with a twenty-three-year follow-up in one case.

In these cases the pathologic findings were almost entirely confined to the spleen, and in one of Kay's cases the spleen weighed 4,800 gm.

Lovelock and Stone [*6,7*] concluded that a majority of patients with pulmonary sarcoidosis show some roentgenographic evidence of improvement following therapy with cortisone or ACTH, but no criteria have been found which permit us to predict the extent of such improvement. A higher percentage of clearing was noted in patients receiving cortisone or ACTH (64 per cent) than in the untreated cases (44 per cent). Roentgenographic evidence of clearing is not always maintained, however, as indicated by one patient who had rapid recurrence after each of two courses of cortisone therapy.

Siltzbach [*14*] concluded that cortisone and corticotrophin generally act favorably upon intrathoracic sarcoidosis, although the benefits usually prove temporary. In chronic pulmonary sarcoidosis the effects of the hormones are variable. Sometimes symptomatic relief is dramatic and sustained. More often the relief is partial, and relapse occurs promptly after the hormones are withdrawn. However, in two cases of splenomegaly treated by this method, no reduction in size was seen although the drug was used for sixty-three days in dosage of 100 to 150 mg. daily. The cases did seem to improve generally.

In 1954 Kay and Royster [*4c*] reported on the use of cortisone in the treatment of sarcoidosis of the spleen. In this condition the spleen can attain great size, causing pressure on all the adjacent organs and consequently requiring splenectomy. These authors found that the risk of splenectomy could be reduced by the preoperative use of cortisone to reduce the size of the spleen.

CASE REPORT

The patient, a thirty-nine year old woman, was referred to the Clinic on September 23, 1953, because of an enlarged spleen. With the exception of the splenomegaly, no abnormality was noted by the examining physician. Bone marrow examination and splenic puncture were negative. All other laboratory examinations were negative. X-rays of the lungs, however, were characteristic of early sarcoidosis, and this was considered the etiology of the splenomegaly.

Inasmuch as the patient was experiencing no particular discomfort from the enlarged spleen at this time, she was sent home to her physician's care and received a course of cortisone, 25 mg. every eight hours, with no appreciable change in the size of the spleen after five weeks. The dosage of cortisone was then doubled, and two months later it was noted that the spleen had been reduced to 3 fingerbreadths below the umbilicus and to the midline, a considerable reduction from the time of the first examination. The cortisone was stopped and there appeared to be no indication for splenectomy at that time.

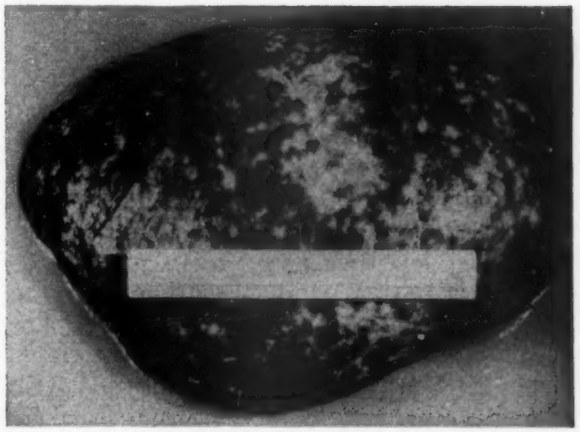

FIG. 1. Longitudinal cross section of spleen illustrating the greatly increased thickness of the organ. Note the mottled appearance produced by the confluence of the sarcoid nodules.

However, on April 29, 1954, seven months after admission, splenectomy was advised but was refused. At this time moderate enlargement of the liver was also noticed. Two months later the patient reported feeling "run down" but again refused surgery. No change in the size of the spleen was noted. A secondary anemia was now present with hemoglobin, 10 gm. per cent, and the red blood cell count 3,100,000 per cu. mm. Blood transfusion was advised, to be followed by splenectomy.

The operation was performed on September 20th. Through a left rectus incision the spleen was explored and found to be approximately ten times normal size. (Fig. 1.) Grossly it had a mottled appearance, undoubtedly the result of sarcoidosis. There were numerous adhesions to the diaphragm, colon, stomach and pancreas. Operation was difficult because it was not possible to isolate the splenic artery after opening the gastrocolic omentum. The vessel was matted in many glands and adhesions. The tail of the pancreas was ligated near its attachment to the spleen. Operation was accomplished

with approximately no blood loss despite the handicaps. The liver presented the same gross appearance as the spleen but did not appear appreciably enlarged. The stomach, colon and other viscera appeared normal.

The postoperative course was uneventful and the patient was discharged on the twelfth day.

The pathologist, Dr. Etheldred Schafer, reported: "The specimen consists of a spleen weighing 2,400 gm. and measuring 29 by 20 and up to 8 cm. in maximum thickness. The capsule is tense, slightly thickened, but a translucent, pale gray except where mottled with yellowish gray, opaque foci and roughened by fibrous tags; some of these are delicate and easily broken. Over the upper pole there is a slight granularity to the capsule, individual granules measuring from 1 to 2 or 3 mm. in maximum diameter. The previously mentioned yellowish-gray foci are slightly depressed. Sections are made with exceedingly great difficulty through the long axis to reveal slightly bulging, light red, cut surfaces having a meaty appearance and mottled with stellate gray foci and dark reddish-purple areas. The fat at the hilus of the spleen contains a number of enlarged, soft, pinkish-red lymph nodes and an irregularly shaped piece of pale pinkish-tan, finely lobulated, pancreatic tissue measuring 3 by 2.5 by 2 cm.

"Microscopic description: Multiple sections show complete obliteration of the splenic architecture by a granulomatous type of inflammation characterized by well circumscribed, circular or oval lesions composed of epithelioid cells, multinucleated giant cells, and small lymphocytes. Most of these lesions are free of central necrosis, but there is extensive necrosis in the intervening portions of the tissues, accompanied by hemorrhage, mixed inflammatory cells and hyalinized fibrosis. The cytoplasm of some of the giant cells is vacuolated; this led to an extensive search for a Histoplasma capsulatum, but none were noted. The necrosis is thought to be secondary to circulatory disturbances by the extensive involvement of the spleen by the above lesions and not an integral part of the granulomas.

"Sections of the accompanying lymph nodes show similar tubercle-like lesions without central necrosis. There are numerous irregularly shaped, whorled, acidophilic masses between the tubercles. In the intervening tissues, there are numerous lymphocytes, plasmacytes, and a few eosinophils. Macrophages are quite numerous; some of these contain golden brown pigment, others have foamy cytoplasm. Asteroid bodies are not noted, although there is a suggestion of one in a giant cell.

"Special stains for demonstration of acid-fast bacilli and fungi fail to reveal these organisms.

"Diagnosis: Nonspecific granulomatous inflammation of spleen and hilar lymph nodes consistent with the clinical diagnosis of sarcoidosis."

On several subsequent visits to the Clinic the patient has been observed by Dr. H. C. Ashman, and her general condition has remained satisfactory. The blood count has remained normal, and no abnormalities of any other organs have been noted, although the liver continues to be slightly enlarged.

CONCLUSIONS

There is no particular reason for performing splenectomy in sarcoidosis except where the spleen reaches such size as to encroach upon and embarrass the other organs.

Because this condition has rarely been noted in the literature, this case is reported.

The preoperative beneficial effect of cortisone in reducing the size of the spleen, as previously reported by Kay and Royster, is reconfirmed.

REFERENCES

1. Cattell, R. B. and Wilson, R. O. Sarcoidosis of the spleen; report of two cases. *Labey Clin. Bull.*, 7: 66, 1951.
2. Freiman, D. G. Sarcoidosis. *New England J. Med.*, 239: 664, 1948; *Ibid.*, 709, 1948; *Ibid.*, 743, 1949.
3. Friedman, M. Sarcoidosis of the spleen; report of a case with autopsy and a study of intracellular "asteroid bodies." *Am. J. Path.*, 20: 621, 1944.

4*a*. Israel, H. L., Senes, M. and Harell, D. Cortisone treatment of sarcoidosis; experience with 36 cases. *J. A. M. A.*, 156: 461, 1954.

4*b*. Kay, S. Sarcoidosis of the spleen; report of four cases with a twenty-three year follow-up in one case. *Am. J. Path.*, 26: 427, 1950.

4*c*. Kay, S. and Royster, H. P. Use of cortisone in treatment of sarcoidosis of the spleen prior to splenectomy. *Surgery*, 36: 798, 1954.

5. Lichtenstein, M. E., Lundy, L. F. and Spinuzza, S. J. Splenectomy in sarcoidosis. *Illinois M. J.*, 104: 378, 395, 1953.
6. Lovelock, F. J. and Stone, D. J. Cortisone therapy of Boeck's sarcoid. *J. A. M. A.*, 147: 930, 1951.
7. Lovelock, F. J. and Stone, D. J. The therapy of sarcoidosis. *Am. J. Med.*, 15: 477, 1953.
8. McClement, J., Renzetti, A. D., Himmelstein, A. and Cournand, A. Cardiopulmonary function

in pulmonary form of Boeck's sarcoid and its modification by cortisone therapy. *Am. Rev. Tuberc.*, 67: 164, 1953.

9. MILLER, M. A. and BASS, H. E. Effect of acthar-C (ACTH) in sarcoidosis. *Ann. Int. Med.*, 37: 776, 1952.
10. RAY, E. S. Sarcoidosis; its diagnosis and management. *West Virginia M. J.*, 52: 200, 1956.
11. RILEY, R. L., RILEY, M. C. and HILL, H. McD. Diffuse pulmonary sarcoidosis; diffusing capacity during exercise and other lung function studies in relation to ACTH therapy. *Bull. Johns Hopkins Hosp.*, 91: 345, 1952.
12. RIPPMANN, E. T. Sarcoidosis. *Bull. Geisinger Memorial Hosp. & Foss Clin.*, 8: 142, 1956.
13. SHULMAN, L. E., SCHOENRICH, E. H. and HARVEY, A. M. The effects of adrenocorticotropic hormone (ACTH) and cortisone on sarcoidosis. *Bull. Johns Hopkins Hosp.*, 91: 371, 1952.
14. SILTZBACH, L. E. Effects of cortisone in sarcoidosis; a study of thirteen patients. *Am. J. Med.*, 12: 139, 1952.

Adrenalectomy in Advanced Cancer of the Breast

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IT has been fairly well established that in the majority of women with primary cancer of the breast metastatic disease eventually develops despite mastectomy and radiation therapy. Park and Lees stated that if treatment has any effect at all, it cannot have done more than to increase the over-all survival rate by more than 5 or 10 per cent. This indicates that metastasis occurs early and that its progress is, however, variable. The variability in different patients is due to the difference in the host-resistance factor in the individuals and also due to the biologic potential of the cancer cells. The latter, in part, may be explained on the concept of hormonal dependence.

Palliative therapy constitutes an important part in the management of patients with advanced carcinoma of the breast. Radiation therapy, endocrine medication and surgery of the endocrine system provide effective palliation in many patients. These modalities not only afford dramatic relief but in many cases temporarily arrest the progress and growth of the disease, thus providing prolongation of useful life.

The report of a dramatic result in the treatment of any disease is occasionally warranted because of the impression it can make on the reader. It keeps the profession cognizant of another modality of therapy for a condition ordinarily considered hopeless.

CASE REPORT

D. F., a seventy-one year old white woman, was first admitted to Goldwater Memorial Hospital, New York, in July, 1952, with cancer of the breast. A radical mastectomy was performed, against my advice, and she then received postoperative radiation therapy according to the McWhirter technic. The pathologic report of the specimen was that of carcinoma simplex and no axillary node involvement could be found. Bone survey in June, 1954, was negative for metastatic lesions. In June, 1955, the patient returned with generalized metastatic disease. The clavicles, ribs, scapula, spine and skull were involved. The skull presented seven nodular masses measuring about 1½ to 2 cm. in diameter, distributed both anteriorly and posteriorly. The nodules were firm and some appeared cystic. An attempt to aspirate several of them was not productive except for the aspiration of blood from one of them. The examination of the aspirated fluid did not reveal cancer cells.

On September 12, 1955, a bilateral adrenalectomy, oophorectomy and splenectomy were performed under general anesthesia through an abdominal approach. The patient had been properly prepared before operation with cortisone and was adequately maintained after operation with 25 mg. daily given by mouth.

The pathologic report of the organs removed revealed no abnormalities of the adrenals and spleen, which had been removed because of trauma; dermoid cysts were found in the ovaries. Three months after operation the nodular masses of the skull had completely disappeared and the patient's general condition had improved remarkably. She had bilateral cataracts and stated that her sight had improved. X-rays of the skull taken in October, 1955, and January, 1956, did not reveal any remarkable improvement. She was discharged in January, 1956, as markedly improved. The patient returned to the hospital one month later with herpes zoster, and in March, 1956, underwent an exploratory operation for a calculus in the right ureter. Her convalescence from this procedure was uneventful. She remained in the hospital in apparently good condition, being maintained on 25 mg. of corti-

sone daily until September 6, 1956, when she suddenly died.

SUMMARY

1. A case of far advanced carcinoma of the breast is presented, in which adrenalectomy and oophorectomy produced dramatic results.

2. This modality of therapy should at least be considered in all apparently hopeless cases of carcinoma of the breast.

3. One should not underestimate the value of palliative surgery.

COMMENT

It is justifiable to go to great lengths to relieve pain or restore function and thus make whatever time remains worth living. It is difficult perhaps to obtain agreement on what is worth the prolongation of life. It depends on the individual circumstances and philosophy. Perhaps one can judge what he would consider an acceptable prolongation of life only when called upon to make such a personal decision: we can judge only from experience gained from the attitudes of others.

Even a short extension may be worthwhile because in a proportion of cases both subjective and objective improvement have been achieved which have never been accomplished before by any other method of treatment. This was well illustrated by the case reported herein.

REFERENCES

DAO, T. L. Y. and HUGGINS, C. Bilateral adrenalectomy in the treatment of cancer of the breast. *Arch. Surg.*, 71: 645, 1955.

PEARSON, O. H. et al. Management of metastatic mammary cancer. *J. A. M. A.*, 159: 1701, 1955.

Primary Hodgkin's Disease of the Stomach

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PRIMARY Hodgkin's disease of the stomach is a rare entity. Isolated gastric lymphogranulomatosis is found even less frequently. In 1832, Thomas Hodgkin described lesions of the stomach and duodenum as a part of generalized Hodgkin's disease. In 1913, Schlagenhaufer [*16*] published the first case of isolated gastric lymphogranulomatosis. Marshall and Aronoff [*12*] reported two hundred fifty-two gastric resections, of which eight were for Hodgkin's disease. Jackson and Parker [*11*] reported one hundred seventy-four cases of generalized Hodgkin's disease, nine of which invaded the gastrointestinal tract and of which only three were gastric. Hayden and Apfelbach [*7*] reported twenty-six cases of gastrointestinal Hodgkin's disease, of which there were but three gastric lesions. In a review of the literature in 1951, Atlee, Rowan and Ziegler [*1*] reported thirty-two cases of gastric Hodgkin's disease. In 1952, Bond and Pileggi [*3*] and Pomeranz [*14*] each added a case and Jackson and Schnell [*10*] added two cases; Sperling [*17*] added one case in 1954. Herzig, Perchanok and Weingarten [*8*] and Fieber [*6*] each added a case in 1955. Dagradi, Reingold and Borreson [*5*] added a case in 1956. Since 1945, three hundred seventy-seven gastric resections have been performed at this hospital without a single previous case of gastric Hodgkin's disease.

CASE REPORT

A fifty-five year old white farmer was admitted to the Robert Packer Hospital on August 29, 1956, with a history of stomach trouble of one year's duration, especially noted in the fall and spring. He reported a sharp pain which was infrequently relieved by food. The pain occasionally radiated to the subscapular area. He was constantly nauseated and had noticed a slightly enlarging epigastrium. He had passed tarry stools and had lost 10 to 12 pounds. He had an aversion to meats, saying that eating them "made him feel funny." His past history disclosed a cataract extraction in the right eye in 1949, hypertension of twenty-five years' duration and frequent headaches. He reported shortness of breath and orthopnea had developed a few years before but no ankle edema had been present.

TABLE 1
GASTRIC ANALYSIS MADE TWO DAYS AFTER ADMISSION

Samples	Free HCl	Combined HCl	Total HCl
Fasting	0	24	24
First	28	10	38
Second	56	14	70
Third	52	18	70
Fourth	48	18	66
Fifth	40	14	54
Sixth	44	10	54

Physical examination disclosed a pale, thin, white man whose usual weight of approximately 175 pounds was currently 158 pounds. There were hard deposits on the ear lobes with a question of tophi. The neck showed one small node on the anterior border of the left trapezius muscle. The lungs were clear and the heart revealed normal sinus rhythm without murmur. The abdomen was tender in the right epigastrium. There were no masses or spasm. A 4 plus guaiac stool was found upon rectal examination. The clinical impression at that time was peptic ulcer or antral carcinoma with hemorrhage and a questionable ulcer diathesis. Gastroduodenal x-ray substantiated an antral lesion but did not differentiate between a long standing chronic inflammatory change and an infiltrating neoplasm.

Laboratory studies revealed a mild anemia, but were otherwise within normal limits. Table 1

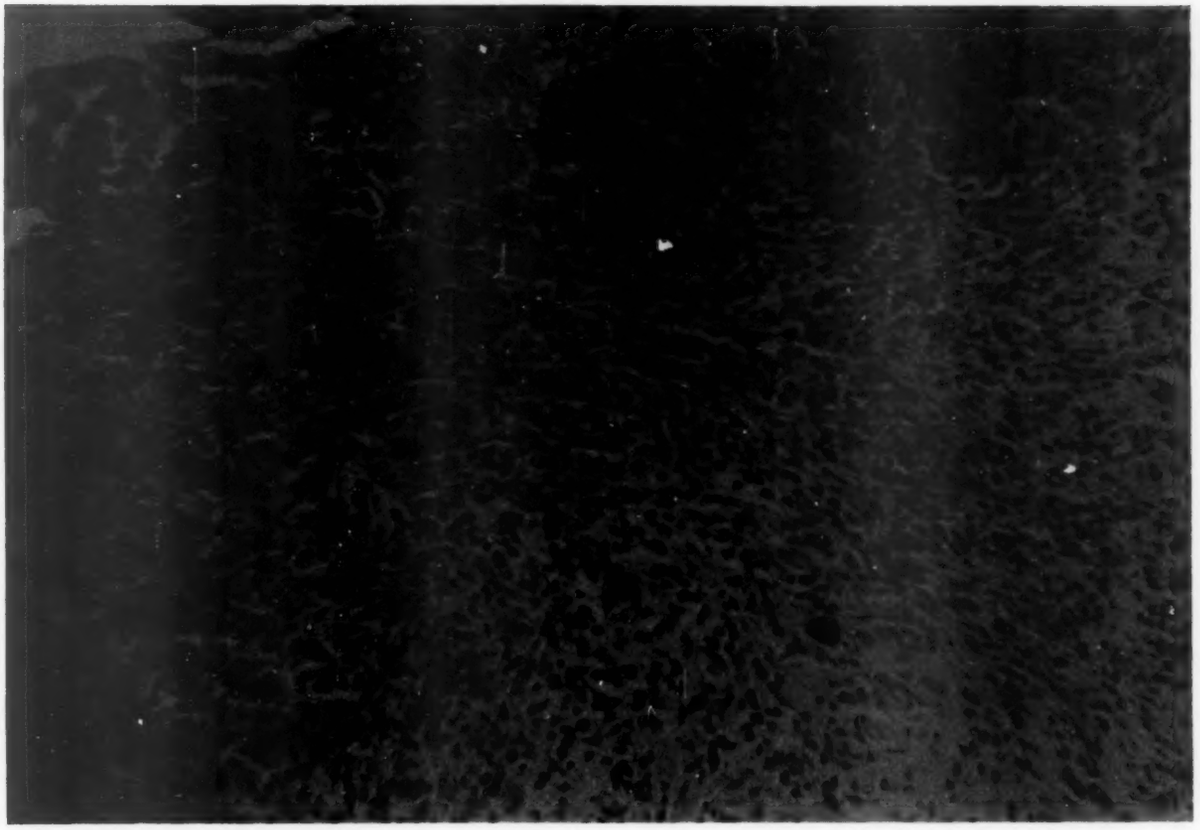

FIG. 1. Base of ulcer with pleomorphic cellular infiltration; original magnification ×100.

shows the results of the gastric analysis made two days after admission.

This patient was thought to be a suitable candidate for gastric resection, and on September 6, 1956, subtotal gastric resection of the Hofmeister type was performed. At operation pyloric obstruction was found although the pylorus was not adherent to the head of the pancreas. There were numerous adhesions from the posterior wall of the stomach to the body of the pancreas and there was a large thick mass present in the lesser curvature of the stomach. There were numerous large lymph nodes scattered throughout the gastrocolic omentum. Frozen section diagnosis was lymphoma of the stomach.

Postoperatively the patient was placed on nasogastric suction and fluid balance was maintained by the intravenous route. The Levin tube was removed on the fourth postoperative day and the patient was given a routine postgastrectomy diet. The postoperative course was uneventful. He received 1,800 r in air to an anterior portal to include the spleen and right kidney. Three hundred r were given daily for a total of six treatments. (Factors: 250 kv., 30 ma., 50 cm., TSC Th III filter.) Following radiation the patient was discharged to be followed up in the Guthrie Clinic at three-month intervals.

PATHOLOGY

The specimen consisted of a single piece of stomach measuring 15 by 10 by 4 cm. in the collapsed condition. Grossly the specimen exhibited two ulcers, one measuring 1.5 cm. in diameter and 0.6 cm. in depth in the pylorus, and the other ulcer measuring 4 by 4 cm. and 0.6 cm. in depth. The ulcers were irregularly shaped along the mid-portion of the lesser curvature. Around each ulcer crater there was a wide confluent zone of firm yellowish infiltration under the mucosa, measuring approximately 10 by 10 cm. and showing no superficial ulceration of the mucosa over it. The rugae appeared relatively normal outside the zone of infiltration of the cardia of the stomach. Permanent sections were obtained. (Figs. 1 and 2.) The final diagnosis was Hodgkin's disease of

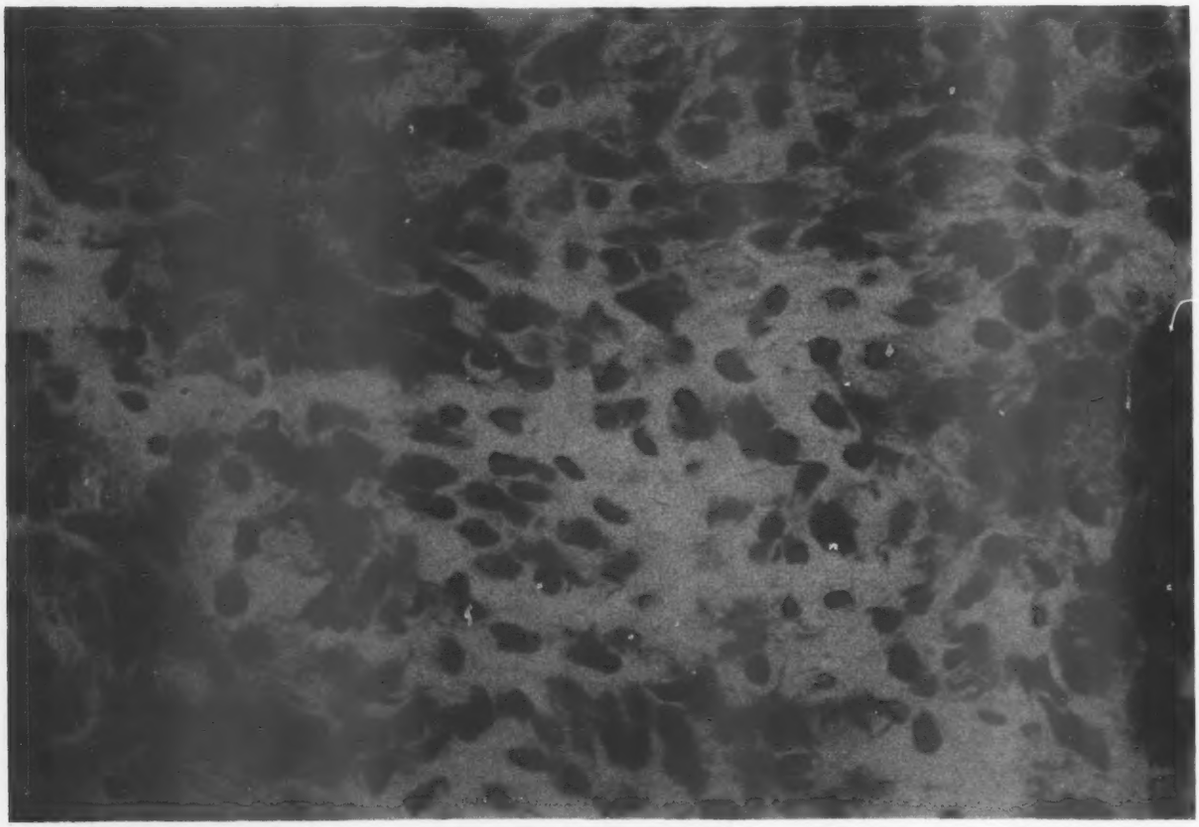

FIG. 2. A higher magnification of the base of the ulcer displaying typical Reed-Sternberg giant cells; original magnification ×930.

the stomach with multiple ulceration and lymph nodes with Hodgkin's paragranuloma.

COMMENTS

Gastric lymphogranulomatosis has no characteristic symptoms, signs or x-ray diagnosis. The disease may present as inflammatory, infiltrative or ulcerative, from both a clinical and radiologic point of view. The correct diagnosis must, therefore, rest with the pathologist. It would seem that in the light of our present knowledge the correct therapy for gastric Hodgkin's disease is a primary gastric resection [*2,4,8,15*]. Radical surgery seems not warranted. There is controversy over the use of radiation and nitrogen mustard therapy [*3,5,10,13*]. Some think it does not prolong life and simply produces symptomatic relief; others believe it to be highly effective. In his review of twenty-seven patients treated with subtotal gastric resection, of which four subsequently received radiation, Fieber found that six patients died in the immediate postoperative period and three had recurrences of the disease or died within one year. Eighteen of the original twenty-seven patients were alive from six months to thirteen years postoperatively, ten of which were alive beyond the five-year period. Marshall and Aronoff believe the prognosis of gastric Hodgkin's disease is much better than gastric carcinoma.

CONCLUSION

A brief summary of the literature is presented on gastric Hodgkin's disease together with the forty-first case report of primary gastric lymphogranulomatosis in which the patient was treated by subtotal gastric resection followed by radiation.

REFERENCES

1. ATLEE, J. L., JR., ROWAN, P. J. and ZIEGLER, E. E. Hodgkin's disease of stomach with free perforation and apparent surgical cure. *Ann. Surg.*, 134: 1052–1057, 1951.
2. BERG, R. Hodgkin's disease of stomach. *Am. J. Surg.*, 76: 219–221, 1948.
3. BOND, L. M. and PILEGGI, J. J. Primary Hodgkin's disease of stomach. *Am. J. Roentgenol.*, 67: 592–595, 1952.

4. Browne, D. C. and McHardy, G. Isolated Hodgkin's disease of stomach. *Gastroenterology*, 6: 596–601, 1946.
5. Dagradi, A. E., Reingold, I. M. and Borreson, R. E. Primary Hodgkin's disease of the stomach; a case report with a note on pathogenesis. *Gastroenterology*, 30: 824–832, 1956.
6. Fieber, S. S. Primary Hodgkin's disease of the stomach. *J. M. Soc. New Jersey*, 52: 76–79, 1955
7. Hayden, H. C. and Apfelbach, C. W. Gastrointestinal lymphogranulomatosis. *Arch. Path. & Lab. Med.*, 4: 743–770, 1927.
8. Herzig, W. F., Perchanok, M. and Weingarten, M. Hodgkin's disease of the stomach with an incidental adenomatous gastric polyp. *Gastroenterology*, 29: 907–912, 1955.
9. Hodgkin, T. On some morbid appearances of the absorbent glands and spleen. *Tr. Med.-Chir. Soc. London*, 17: 68–114, 1832.
10. Jackson, A. S. and Schnell, E. B. Hodgkin's disease of stomach. *Wisconsin M. J.*, 51: 679–683, 1952.
11. Jackson, H., Jr. and Parker, F., Jr. Hodgkin's Disease and Allied Disorders. New York, 1947. Oxford University Press.
12. Marshall, S. F. and Aronoff, B. L. Symposium on gastro-intestinal surgery; tumors of stomach. *S. Clin. North America*, 24: 607–617, 1944.
13. McGroder, E. T. and Mann, L. S. Hodgkin's disease of stomach. *Am. J. Surg.*, 75: 628–632, 1948.
14. Pomeranz, A. A. Hodgkin's disease of stomach. *J. Mt. Sinai Hosp.*, 18: 358–361, 1952.
15. Sandick, H. Hodgkin's disease involving stomach. *Gastroenterology*, 15: 135–143, 1950.
16. Schlagenhaufer, F. Ueber granulomatosis des Magendarmtrakts. *Zentralbl. f. allg. Path. u. path. Anat.*, 24: 965–966, 1913.
17. Sperling, L. Malignant lymphoma of gastrointestinal tract. *Arch. Surg.*, 68: 179–190, 1954.

Congenital Pulmonary Cyst

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THE congenital pulmonary cyst is a malformation resulting from a segmentation of portions of the main lung buds and a subsequent cystic dilatation of this underdeveloped bronchopulmonary segment by an accumulation of air or of fluid secreted by the lining epithelial cells [1]. Congenital cysts are characterized by a lining of bronchial epithelium of the columnar or cuboidal type, or by epithelium representing a compressed alveolar type cell and the presence of smooth muscle and cartilage within the wall. Acquired cystic lesions lack this characteristic lining. Other cystic conditions of the lung which may enter into the differential diagnosis vary with the site of the congenital cyst and the complications which may have supervened. Accordingly, congenital cysts have been mistakenly treated as spontaneous pneumothorax, cavitary pulmonary tuberculosis, lung abscess, bronchiectasis and empyema. In the newborn these congenital cysts may simulate the x-ray findings of congenital diaphragmatic hernia. The history of the disease and x-ray studies will aid in differentiation. Histologic study of the specimen will make the irrefutable diagnosis.

The incidence of congenital pulmonary cysts is difficult to assess since smaller ones may remain entirely asymptomatic and some others not become evident until adult life when their complications make confusion with other pulmonary diseases a greater possibility. Certainly, the congenital cyst is far less common than the similar acquired lesion. Several reported series note the higher incidence in males, but the relatively small number of cases in all series makes it difficult to state this difference in figures. An examination of immigrants to Israel aimed at the detection of tuberculosis revealed a surprisingly high incidence which has been analyzed by Lichtenstein [2]. The number of patients examined is not given more specifically than as several hundred thousand immigrants, but it is reported that in a one-year period covering 1950 to 1951, 188 cases of pulmonary cysts were detected, of which ninety-six were acquired, mainly echinococcus, and ninety-two were assumed to be of the congenital variety. These ninety-two cases comprised sixty-two males and thirty females.

Congenital pulmonary cysts may become evident shortly after birth if they occupy a major portion of one lung at that time. If the cyst is so small that pulmonary physiology is undisturbed, or if it enlarges slowly, its presence may not be manifest for years. The cysts in which there is not a patent connection with the bronchial tree are more likely to be asymptomatic. One of the most important factors in the promotion of complications is the status of the bronchial communication which may permit air to enter, but not to leave the cyst. With progressive distention of the cyst, there will be recurrent attacks of cyanosis, dyspnea and cough. In the infant this cyanosis and dyspnea will be noted following a period of crying or struggling during which additional air enters the cyst, but cannot be released because of the valvular action at the bronchial communication. The bronchial communication is also the source of the inevitable infection arising in such cysts and generally manifested by cough, expectoration, fever, anorexia, weight loss, and rarely, chest pain. Less frequent complications of congenital cysts are hemorrhage and spontaneous pneumothorax. Malignant degeneration has been reported in two cases [3].

Surgical extirpation of the cyst before the appearance of complications is a notably easier and safer procedure. Since there seem no criteria by which we can judge how long a given

cyst will remain asymptomatic, and since the dormant cyst may suddenly precipitate a critical emergency in the way of spontaneous pneumothorax or severe pulmonary infection, the indication for surgery seems to be the mere presence of such a cyst. Furthermore, some of the still asymptomatic cysts are enlarging slowly at the sacrifice of full aeration of the remaining tissue and normal position of mediastinal structures. Reports in the literature have demonstrated not only the hazards of such cysts in which complications supervene but also the safety with which the uncomplicated lesion can be surgically treated in the very young infant [*4–10*]. In the years before surgical excision was widely accepted as the therapy of choice, the mortality of the disease was very high, especially in infants and children. In a review of the disease up to 1935, Schenck and Stein report a 69 per cent mortality in a group of fifty-one cases seen between 1925 and 1935 [*11*]. The next decade witnessed a slow trend toward surgical extirpation of the disease as soon as any complication had arisen. Since 1945 there have been several reported series treated surgically with great satisfaction. These reports include instances of pulmonary resection, lobectomy or pneumonectomy in young infants without surgical mortality despite the presence of severe complication by the time surgery was undertaken. These same reports contain the more unhappy stories of those who died after prolonged illness from the complications of tardily discovered and treated cysts [*12–15*].

In the majority of reported cases the pulmonary cyst was recognized and treated only after some complication had prompted its diagnosis and made its removal a relative necessity. It is probable that a keener appreciation of this lesion and the hazards of delay in treatment would be a worthy advance in both pediatric and surgical thinking.

This paper adds to the reports of successfully removed cysts in infants the case of a six month old male infant whose very large, but apparently asymptomatic, congenital pulmonary cyst was discovered at a routine physical examination.

CASE REPORT

B. N. (Hosp. No. A56290), weighed 4,100 gm. at his birth on October 30, 1955. The immediate postnatal course was normal and at the time of discharge examination on the fifth day the examining pediatrician found no demonstrable pulmonary disease. At the time of the baby's six-month visit, the mother reported a mild dry cough for the preceeding three or four weeks and a failure to gain weight as rapidly as he had prior to that time. There was no dyspnea or cyanosis, and the child appeared generally healthy, although small for his age. The point of maximal cardiac impulse was found to lie to the right of the sternum, and there was a hyper-resonance over the entire left thorax. A chest x-ray taken two days later showed an enormous cystic lesion occupying the left thorax. (Fig. 1.) Mediastinal structures were displaced beyond the midline to the right, compressing the right lung to about one-third its original volume. The margins of the cyst were visible on the x-ray as linear streaks.

FIG. 1. Preoperative x-ray of chest. Large pulmonary cyst has displaced the heart far to the right. The right lung is compressed. The diaphragm is depressed; the trachea is deviated.

On May 9, 1956, thoracotomy was performed with the infant under endotracheal anesthesia. The operative findings included a huge cystic lesion of the left lower lobe which compressed the left upper lobe so that it was totally atelectatic. The mediastinum was displaced and the left diaphragm depressed. Left lower lobectomy

FIG. 2. Microscopic section of wall of pulmonary cyst. The cyst is lined by columnar epithelium beneath which is a distinct layer of smooth muscle. These two features are characteristic of a congenital pulmonary cyst.

FIG. 3. X-ray of chest three months after removal of the pulmonary cyst. The mediastinal structures are in the midline. The left hemithorax is well filled by the remaining upper lobe.

was performed. An accessory artery to the superior aspect of the lower lobe was identified, ligated and divided. A catheter was placed in the left thorax before closure, brought out through a stab wound in the anterior axillary line, and attached to water-seal drainage. At the conclusion of the lobectomy, the left upper lobe could be expanded under pressure.

Recovery was rapid and uncomplicated. By the first postoperative day the mediastinal structures had returned to the midline. The left upper lobe remained well expanded, filling more than half of the left thorax. The previously compressed right lung was now fully expanded.

Pathologic examination confirmed the clinical impression of congenital pulmonary cyst. (Fig. 2.) The specimen was described as an irregularly pyramidal cystic mass, measuring 10 by 5 by 6 cm. On one surface there was a recognizable bronchus and recognizable lung tissue. No bronchial connection could be demonstrated. Microscopically, the cyst was found to be lined by columnar epithelium, beneath which there was a layer of smooth muscle, indicating the bronchial origin of the cyst.

The baby was discharged twelve days after operation to the care of his pediatrician. Three months postoperatively he was well, gaining weight and entirely asymptomatic. Chest x-ray at this time showed normal position of all mediastinal structures. (Fig. 3.) The left upper lobe was well expanded and filled the major part of the left thorax.

It seems incredible that a cyst of such proportions could fail to cause marked distress to the infant. It is certain, however, that its quiescence must soon have given place to some complication which would have made its surgical re-

moval more difficult and dangerous. This case supports the findings of other authors that corrective surgery of pulmonary cysts in infancy is not unduly risky, untreated the lesion is hazardous, and prompt excisional surgery properly follows the diagnosis.

SUMMARY

The successful removal of a large congenital pulmonary cyst in a six month old infant is reported. The potentially serious nature of this type of lesion is emphasized, and early extirpative surgery before the appearance of complication is recommended.

REFERENCES

1. Herbut, P. A. Surgical Pathology. Philadelphia, 1948. Lea and Febiger.
2. Lichtenstein, H. Congenital multiple cysts of the lung. *Dis. of Chest.*, 24: 646–654, 1953.
3. Moersch, H. J. and Clagett, O. T. Pulmonary cysts. *J. Thoracic Surg.*, 16: 179–199, 1947.
4. Burnett, W. E. and Caswell, H. T. Lobectomy for pulmonary cysts in a fifteen day old infant with recovery. *Surgery*, 23: 84–91, 1948.
5. Crowe, G. G. Congenital cystic lung; successful pneumonectomy in a three week old baby. *J. Thoracic Surg.*, 27: 399–401, 1954.
6. Gross, R. E. Congenital cystic lung. *Ann. Surg.*, 123: 229–237, 1946.
7. Johnson, J. The surgical treatment of congenital pulmonary emphysema and cysts. *Pennsylvania M. J.*, 57: 809–814, 1954.
8. Potts, W. J. Acquired and congenital cysts of the lung in infants and children. *Postgrad. Med.*, 16: 34–38, 1954.
9. Smid, A. C., Ellis, F. H., Logan, G. B. and Olsen, A. M. Partial respiratory obstruction in an infant due to bronchogenic cysts; report of case. *Proc. Staff Meet., Mayo Clin.*, 30: 282–287, 1955.
10. Swan, H. and Aragon, G. E. Surgical treatment of pulmonary cysts in infancy. *Pediatrics*, 14: 651–658, 1954.
11. Schenck, S. G. and Stein, J. L. Congenital lung cysts in infants and children. *Radiology*, 24: 420–428, 1935.
12. Albert, H. M. and Potts, W. J. Congenital lung cysts in infants. *Pediatrics*, 12: 283–287, 1953.
13. Byrum, R. J. Congenital cystic disease of the lung. *J. Pediat.*, 38: 511–515, 1951.
14. Eloesser, L. Congenital cystic disease of the lungs. *Surg., Gynec. & Obst.*, 52: 747–758, 1931.
15. Ravitch, M. M. and Hardy, J. B. Congenital cystic disease of the lung in infants and children. *Arch. Surg.*, 59: 1–36, 1949.

Retroperitoneal Rupture of the Duodenum Due to Blunt Trauma

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THIS article reports a case of retroperitoneal transection of the duodenum, with acute hemorrhagic pancreatitis due to blunt abdominal trauma, in which the patient recovered. It is of interest because of the rarity of survival and because of the successful application of two new methods of care.

Retroperitoneal duodenal injuries represent about 10 per cent of intestinal injuries due to blunt trauma [2]. Schumacher in 1910 and Miller in 1916 summarized forty-six case reports, with a mortality of 89 per cent [3,4]. Cohn in 1952 summarized twenty-five case reports dating from 1943, with a mortality of 20 per cent [1].

Few of the reported survivors had multiple injuries. No cases of this injury with acute hemorrhagic pancreatitis were noted in these or other reports reviewed.

CASE REPORT

B. B., a seventeen year old white girl, was injured when her horse reared over on her. She was momentarily unconscious. She was admitted to St. John's Hospital immediately after the injury on October 23, 1955. Temperature was 98.6°F., pulse 86, respirations 20 and blood pressure 110/70. Examination revealed a soft abdomen with generalized tenderness and normal bowel sounds. White blood cell count was 16,500 per cu. mm. with 93 polymorphonuclear leukocytes, 6 lymphocytes and 1 eosinophil. Hemoglobin was 13.4 gm. per cent; red blood cell count was 4,400,000 per cu. mm. Urinalysis was negative for sugar, with a trace of albumin; microscopically, there were 30 to 40 red blood cells per high power field.

After admission she vomited several times. Four hours later there was some guarding and mild rebound pain in the abdomen. Bowel sounds were scant. A Levin tube was inserted. Abdominal x-rays were negative for free air. Intravenous pyelograms revealed no renal abnormality. Fractures of lumbar transverse processes 1, 2, 3 and 4 were seen on the left.

The patient's condition seemed improved and sedation was administered.

Sixteen hours after the injury the patient became restless, pulled out the Levin tube, and vomited. At eighteen hours the abdomen was rigid and silent. The pain localized to the right lower quadrant. Temperature was 99.4°F., pulse 140, respirations 22 and blood pressure 94/70. White blood cell count was 22,000 per cu. mm., with 90 polymorphonuclear leukocytes and 10 lymphocytes. Red blood cell count was 5,300,000 per cu. mm. Serum amylase was 202 Somogyi units. Repeat films of the abdomen did not reveal free air. The diagnosis was intra-abdominal injury.

At twenty-one hours after the injury, with the patient under endotracheal anesthesia, a transverse incision was made across both recti 1 inch above the umbilicus. There was brown-tinged free fluid in the peritoneal cavity. The omentum was reddened and edematous and adhered to the cecum. When the omentum was removed from the cecum, fluid was observed oozing from under the cecum. The right colon was pushed anteriorly by a copious retroperitoneal collection. The right colon was freed laterally from below upward. When the transverse mesocolon was liberated over the duodenum a complete transection of the third part of the duodenum was found. The pancreas was very edematous and hemorrhagic. Early fat necrosis was present on surrounding tissues.

It was elected to close the severed ends of the duodenum. The presence of excessive retro-

peritoneal spillage mediated against duodenal anastomosis. The closures were made with continuous No. 000 atraumatic® chromic catgut and a second layer of interrupted Halsted sutures of intestinal cotton.

Two-layer posterior gastrojejunostomy was performed. A second Levin tube was inserted in the other nostril and passed into the distal jejunum through the anastomosis for feeding purposes.

The foramen of Winslow, retroduodenal area and right colic gutter were drained with three Penrose drains. Chromic catgut and retention sutures of nylon were used in the wound closure. The anesthesia lasted two hours. Two pints of blood were given during the operation. The blood pressure ranged from 80 to 100 systolic.

Immediately postoperatively and for the next forty-eight hours the blood pressure was held within recordable levels of 70 to 100 systolic only by continuous drip of levophed® per cutdown. Blood, solu-cortef I.V. and cortisone I.M. were given during this period to obtain a sustained blood pressure.

On the eleventh postoperative day a massive duodenal fistula developed with up to 1,500 cc of drainage daily. This continued for twelve days. The fistula was demonstrated with lipiodol® x-ray visualization. Wound suction was carried out and the drainage was collected for readministration by nasal feeding tube. The fistula closed without other treatment. The patient was discharged on the fortieth postoperative day.

At six months, upper gastrointestinal films revealed good function of the gastroenterostomy. The blind stump of duodenum was narrowed and would not admit barium for visualization. There were no gastrointestinal complaints. She regained her previous weight and has remained well.

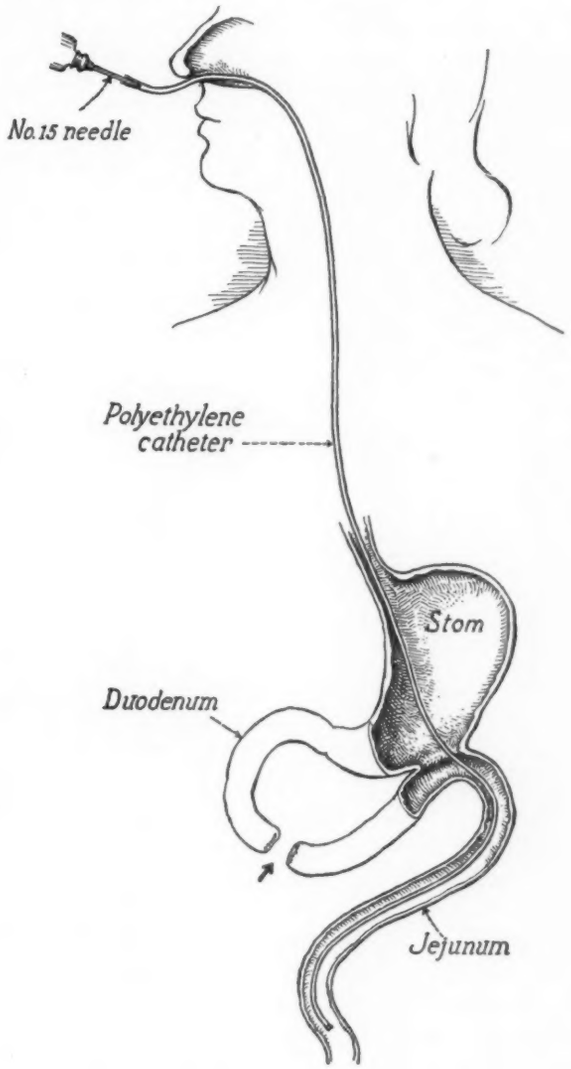

FIG. 1A. Polyethylene tube in place.

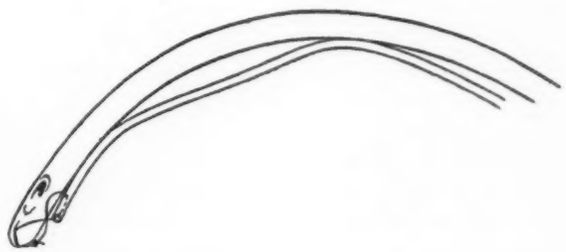

FIG. 1B. Polyethylene tube with catheter for insertion into jejunum.

COMMENTS

The case presented was particularly difficult. The acute hemorrhagic pancreatitis with its severe shock period would have been fatal, we believe, without levophed. The delay in operating added much to the morbidity and should have been avoided by operation within six hours after injury. This would have afforded ample time for fundamental examination and studies.

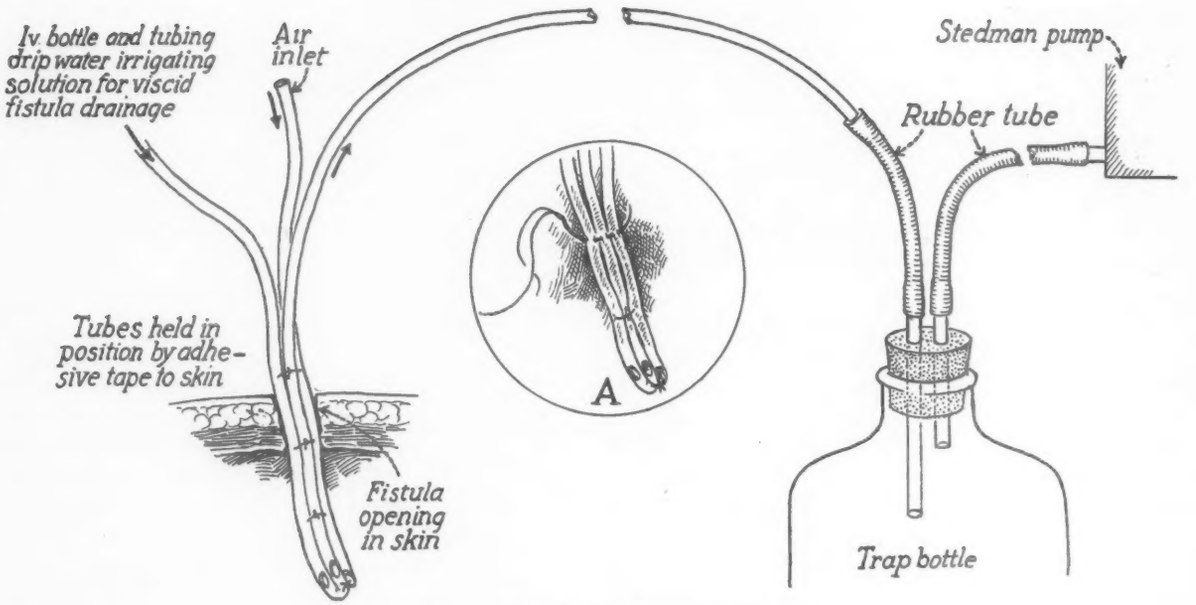
Iv. bottle and tubing drip water irrigating solution for viscid fistula drainage
Air inlet
Stedman pump
Rubber tube
Tubes held in position by adhesive tape to skin
A
Fistula opening in skin
Trap bottle

FIG. 2. Wound suction apparatus.

Two measures used in the care of this patient were of great help. Since they are not in general use we will describe them. The first is the use of fine polyethylene tubing. This can be passed beyond a site of intestinal repair or anastomosis at the time of surgery and used for nourishment when intestinal function is restored. The second is wound suction tubing which serves both to prevent skin excoriation and to collect fistula juices for return via the feeding tube.

Polyethylene tubing (P.E.) 260 is used for intestinal alimentation. (Figs. 1A and B.) It adapts to a No. 15 needle and will allow free flow of high caloric liquid food. To pass this tubing during operation a plastic Levin tube is inserted into the stomach through the nose. One end of a 5 foot length of polytube is sutured to the Levin tube in the stomach and brought out through the nostril by pulling the Levin tube out. The other end of the tube is pushed about 12 inches into the efferent jejunum from the site of anastomosis. To do this a 1 inch loop of plain catgut is sutured to the end of the tube. This loop is engaged in a slit cut in the leading end of a No. 26 F Robinson catheter. The catheter is easily pushed along the lumen of the small bowel. The catgut loop is disengaged when the catheter is withdrawn, leaving the feeding tube in place. For passage in the postoperative period the tube can also be passed directly through the nose and guided through a fairly small anastomosis by use of a small rubber bag of mercury. (In our case we used a Levin tube passed through the anastomosis for feeding at operation but passed a polytube later. We have passed several polytubes for feeding purposes during surgery, however, since then by the aforementioned method.) The small polyethylene tube is well tolerated over a prolonged period. The nourishment possibilities are unlimited.

The wound suction device is easily constructed with discarded plastic intravenous tubing. (Fig. 2.) Three segments of tubing are fixed side-to-side with silk sutures sewn through their walls. Holes are cut near the ends on opposing sides of the tubes. One tube acts as an air inlet to maintain continuous flow. The remaining tube can be used for a continuous drip of water if the fistula contents becomes too thick or viscid. The contents of the trap bottle are strained through gauze and returned via the polyethylene tube. In our case the patient drained up to 1,500 cc. of fluid daily from a duodenal fistula. There was no excoriation and no critical fluid balance problem. The fistula closed spontaneously.

SUMMARY

A case is presented of retroperitoneal transection of the duodenum, with acute hemorrhagic pancreatitis, in which the patient recovered. The use of a fine polyethylene tube for feeding

and return of fistula juices is described. A method for wound suction of fistula is described.

Acknowledgment: Dr. James Barron, Department of Surgery, Henry Ford Hospital, Detroit, Michigan, developed the technic for feeding tube and wound suction described herein. The illustrations were prepared by Mr. Tom Jones, Head of the Medical Illustration Department, University of Illinois Medical School, through the courtesy of Abbott Laboratories.

REFERENCES

1. Cohn, I., Hawthorne, H. R. and Frobese, A. S. Retroperitoneal rupture of the duodenum in nonpenetrating abdominal trauma. *Am. J. Surg.*, 84: 293, 1952.
2. Cooke, H. H. Traumatic rupture of the intestine caused by automobile accidents. *Ann. Surg.*, 96: 321, 1932.
3. Miller, R. T. Retroperitoneal rupture of the duodenum by blunt force. *Ann. Surg.*, 64: 550, 1916.
4. Schumacher, E. D. Zur Duodenum—Chirurgie. *Beitr. z. klin. Chir.*, 71: 482, 1910.

Intussusception of the Appendix Due to Carcinoma

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INTUSSUSCEPTION of the appendix is still considered a rare condition; about 100 cases have been reported since 1858 when McKidd [1] reported the first case in a seven year old boy. In 1910 Moskowitz [2] reported twenty-four cases which he accepted as irrefutable. In 1943 Fraser [3] reviewed seventy-five cases and discussed the etiology and morbid anatomy, and cited his own case in a thirty year old woman who had had an intussusception of the appendix produced by a mucocele. He also reported a case in a seventy-five year old woman, in whom resection for carcinoma of the cecum was performed and as an incidental finding the intussusception of the appendix was noted. In 1953 Forshall [4] reported seven cases which occurred in children. It may well be that the condition is more prevalent than the literature indicates.

Intussusception may be of the simple or compound variety. In the simple type the appendix alone is involved, whereas in the compound type the ileum, cecum or ascending colon may be involved. The simple type occurs most frequently in patients who have (1) a fetal type of cecum with the appendix arising from its tip, (2) an appendix with a wide-mouthed base, (3) a thin mesoappendix which is free from fat with a narrow base, (4) an appendix that has a mobile appendiceal wall, and (5) an appendix which is not fixed by congenital peritoneal folds or adhesions. These are all anatomic conditions which predispose to simple intussusception of the appendix. Other factors which cause increased peristaltic action in the wall of the appendix, such as fecaliths, foreign bodies, worms, hypertrophic lymphoid follicles, papillomas, polyps, endometriomas or carcinoids, are factors in the production of this lesion. In the simple forms of intussusception (1) the tip of the appendix becomes the intussusceptum and invaginates into the proximal portion of the appendix which forms the intussuscipiens; (2) the invaginations can start at the junction of the appendix and the cecum where the appendix is the intussusceptum and the cecum is the intussuscipiens (the most common type of intussusception); (3) the invagination can start at any point along any portion of the appendix (very rare type); (4) a retrograde type of intussusception where the proximal portion of the appendix invaginates into the distal end; (5) there may be complete invagination of the appendix into the cecum. These constitute the simple type of intussusception, which can progress and produce a compound or secondary intussusception of the cecocolic variety, in which cases the invaginated appendix forms the apex of the intussusception. In the compound type the appendix is the primary factor and secondarily involves the structures in the cecocolic region. Cases have been reported in which the appendix has been drawn into a mass involving the structures in the ileocecal region, as in cases of ileocecal, ileocecal colonic or cecocolic intussusception. These cannot be classified as true types of appendiceal intussusception.

The case presented herein is of interest because the appendiceal intussusception was produced by a papillary adenocarcinoma of the appendix and because it occurred in a fifteen year old boy. We have not been able to find, up to the time of the present writing, a case that lists this condition as the factor in the production of an appendiceal intussusception.

CASE REPORT

N. S., a fifteen year old white boy, stated that one month prior to examination in December, 1954, he had been seized with a colicky pain in the right lower quadrant of the abdo-

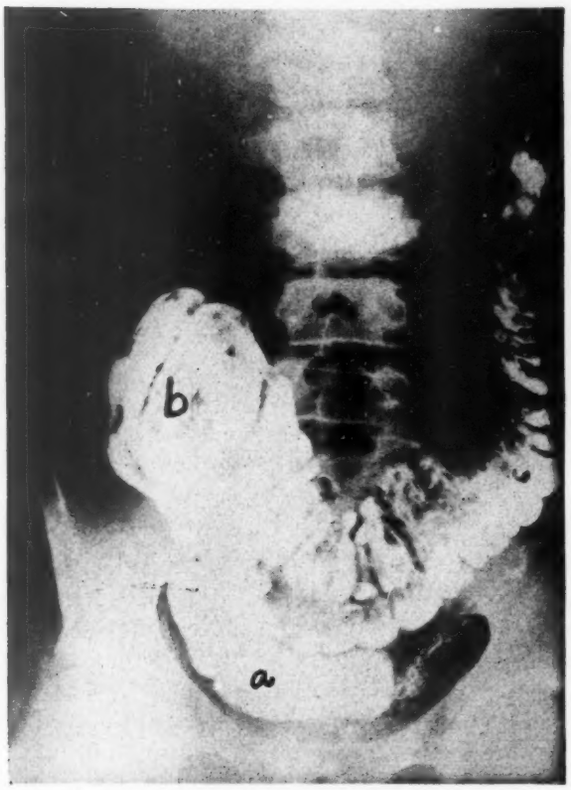

FIG. 1. X-ray taken six hours after barium meal shows dilated terminal ileum (*a*) and cecocolic intussusception (*b*).

FIG. 2. X-ray taken twenty-four hours after barium meal shows appendix (*a*) and cecocolic intussusception (*b*) and (*c*).

men; this pain radiated to his back. The attacks were intermittent, lasting a few minutes and then ceasing. However, the pain would recur every few days and would continue for about twenty-four hours. The boy experienced no nausea or vomiting during the attacks of pain. His bowels were regular and he did not notice any blood or mucus in the stool. His appetite was fair and he did not lose any weight. No dysuria or hematuria was noted. Three weeks following the original attack he had a recurrence of the pain in the right lower quadrant; the pain was more intense and lasted a few hours.

Physical examination showed a pale, thin, fifteen year old boy of stunted growth, whose physical makeup was that of a ten year old boy. Ears, nose and throat were normal. The chest was flat. Heart and lungs were normal. The abdomen was of the scaphoid type. No distention or visible peristalsis was noted. On palpation the liver, kidneys and spleen were not enlarged or tender. No tumor masses were palpated. There was tenderness over McBurney's point and a crepitating cecum was detected. No muscle spasm or rebound tenderness was noted. Rectal examination showed no abnormalities. In view of the negative findings, except for the tenderness over the appendiceal region, it was deemed advisable that the patient have a complete gastrointestinal series. X-ray examination showed normal filling of the stomach; there were no defects in the fundic or pyloric portions, or along the curvatures. The duodenal bulb outlined normally and the stomach emptied after six hours. The six-hour film revealed some dilatation of the terminal ileum and evidences of cecocolic (Fig. 1) intussusception. The appendix was not visualized in this film. In the twenty-four-hour film there was a filling defect with irregular striped formations which were ring-like and spiral-shaped. These were offshoots of the barium which filled the narrow spaces between the cecum and the ascending colon. (Fig. 2.) These findings, according to Dahl [*5*], are pathognomonic of cecocolic intussusception. In forty-eight hours (Fig. 3) the apex of the intussuscipiens was outlined by gas and had assumed a convex contour just beyond the hepatic flexure. Some of

FIG. 3. X-ray taken forty-eight hours after barium meal shows appendix (*a*), papillary tumor of appendiceal base intussuscepted into cecal wall (*b*) and cecocolic intussusception (*c*).

FIG. 4. Resected specimen. (*a*) Intussuscepted appendix. (*b*) Cecal wall. (*c*) Papillary tumor, base of appendix and cecal wall.

the transverse striations were still noted between the invaginated cecum and ascending colon. The appendix was filled with barium and the cecal wall encircled the invaginated portion of the appendix. Proximal to the lower cecal wall, barium could be seen incorporated in a papillary tumor of the appendix. In view of these findings a preoperative diagnosis of cecocolic intussusception was made and the patient was admitted to the hospital for surgery.

At operation the abdomen was entered through a right rectus muscle-splitting incision. The omentum was found to be adherent to the cecum and ascending colon. Following the division of the omental adhesions, the cecum was freed and could be brought down into the right iliac fossa. No masses were felt in the ascending or transverse colon. The cecum was delivered through the incision, and lying on the lateral aspect was a sausage-shaped appendix the size of a thumb. The proximal third of the appendix was invaginated into the wall of the cecum and formed the intussusceptum. On palpating the intussusceptum through the cecal wall, a hard, mushroomlike tumor could be felt. The mesoappendix was thin and contained a small amount of fat. The lymph nodes were not enlarged. Some free fluid was present in the peritoneal cavity. A 2 inch cuff of the cecal wall was removed together with the appendix. The wall was closed with two layers of No. 00 chromic catgut, one layer consisting of the mucosa and muscularis, and the second layer of the serosa. The cecum was redeposited into the abdominal cavity and anchored in the right iliac fossa to the lateral parietal peritoneum. The abdomen was closed in layers without drainage.

On gross examination of the specimen (Fig. 4) the visible portion of the appendix measured 9 cm. in length and 1½ cm. in its widest diameter. The external surface was covered by a greyish yellow, smooth, glistening serosa. The proximal 2 cm. of the appendix was found invaginated into the cecum. The mucosa was reddish brown in color and had a papillary appearance. The same papillary appearance was present on cross section. The wall of the appendix was thick and had a wide lumen. Elsewhere the mucosa appeared hyperplastic. There was a small amount of fecal material in the distal portion of the appendix. The mucosa of the cecum at the place of origin of the appendix was definitely hyperplastic, and papillary overgrowth was obvious over an area 3 cm. in diameter including the lumen of the appendix at this site. Microscopic examination disclosed a papillary carcinoma involving both the appendix and cecum at the locations noted heretofore. (Figs. 5 and 6.)

FIG. 5. Photomicrograph of appendix.

FIG. 6. Photomicrograph of cecum.

The patient made an uneventful recovery and left the hospital eight days after operation. One month after surgery he was free from any pain referable to the right lower quadrant of the abdomen; his bowels were functioning properly and his appetite had improved. A barium colon enema at this time failed to reveal any pathologic disease in the cecum, or ascending, transverse or descending colon. A one and a half year check-up revealed that the patient was in normal health, had grown 2 inches and had gained 10 pounds.

COMMENTS

From July, 1951 to January, 1953 twelve cases of intussusception of the appendix were reported. Zeifer [*6*] in 1951 gave the cause of intussusception in his case as a compound type with an incidental finding of a mucocele of the appendix. In 1951 Hickenbotham [*7*] reported the case of an intussuscepted appendix produced by an argentaffin tumor. Dunavant and Wilson [*8*] reported a case of intussusception of the appendix which was completely inverted and protruded from the anus. In 1952 Altman, Ackerman and Hoffman [*9*] reported a case of invagination of the appendix into itself. In 1952 Morton and Oakman [*10*] presented a case of primary intussusception caused by endometrial rests within the appendiceal wall. In 1953 Forshall [*4*] reported a series of seven cases of intussusception of the vermiform appendix which occurred in children. In five cases the invagination of the appendix was incomplete. In six of these seven cases secondary cecocolic intussusception had occurred.

In reconstructing the sequence of events in our case, it appears from the roentgen findings that the patient had a compound type of intussusception, i.e., appendiceal cecocolic variety. At surgery the cecocolic component was reduced and the appendiceal intussusception persisted as a result of the papillary adenocarcinomatous tumor which involved the base of the appendix. No other case in the literature lists papillary adenocarcinoma as the precipitating factor in the production of appendiceal intussusception occurring in a young boy fifteen years of age.

From a clinical point of view the diagnosis of appendiceal intussusception is rather difficult to make. We should, however, entertain the possibility of this lesion whenever a patient gives a history of intermittent cramp-like pains localized in the right lower quadrant of the abdomen lasting for a few minutes, recurring and then followed with a period of well-being. Nausea, vomiting and bloody stools are late findings when the intussusception has become compounded. If the physical findings reveal nothing of any significance, either a gastrointestinal series or a barium colon enema should be done. More frequent diagnoses of this lesion could be made if one remembers the roentgenographic findings as emphasized by Dahl, i.e., (*a*) a filling defect in the ascending or transverse colon associated with (*b*) irregular markings which are stripe-formed, ring-like or spiral-shaped. These are offshoots of barium which fill the spaces between the intussuscipiens and the intussusceptum. If the barium is ingested, the apex of the intussuscipiens will assume a convex appearance; and if a barium colon enema is given, the apex will assume a concave outline. In this case the gastrointestinal series aided in establishing a working diagnosis of cecocolic intussusception. After operation the x-ray films were reviewed. The forty-eight-hour film definitely revealed the proximal third of appendix with the tumefaction invaginated into the cecal wall. The photograph of the pathologic specimen showed the papillary tumor with the cuff of cecum enveloping the base of the appendix. Transposition of the photograph onto the x-ray film showed the precise nature of the lesion as it was found at operation and on the x-ray film.

REFERENCES

1. McKidd, J. *Edinburgh M. J.*, p. 793, 1858.
2. Moskowitz, A. V. *M. Rec.*, 78: 1087, 1910.
3. Fraser, K. Intussusception of the appendix. *Brit. J. Surg.*, 31: 23, 1943.
4. Forshall, I. Intussusception of the vermiform appendix with report of seven cases in children. *Brit. J. Surg.*, 40: 305, 1953.
5. Dahl, J. F. Roentgen Examinations in Acute Abdominal Conditions, pp. 172–174, Fig. 8, p. 153. Springfield, Ill., 1951. Charles C Thomas.
6. Zeifer, H. D. Intussusception of the appendix. *J. Mt. Sinai Hosp.*, 18: 125, 1951.
7. Hickinbotham, P. Inversion of the appendix. *Brit. J. Surg.*, 39: 84, 1951.
8. Dunavant, D. and Wilson, H. Intussusception of the appendix with complete inversion of appendix and protrusion from anus. *Ann. Surg.*, 135: 287, 1952.
9. Altman, D. B., Ackerman, M. and Hoffman, H. S. Intussusception of the vermiform appendix. *J. A. M. A.*, 149: 1133, 1952.
10. Morton, P. C. and Oakman, C. S. Primary intussusception of the appendix with endometrial implants. *Am. J. Surg.*, 84: 734, 1952.
11. Mitchell, E. W. Intussusception of the appendix. *Canad. M. A. J.*, 25: 194, 1931.
12. Reitz, C. B. Malignant carcinoids and carcinoma of the vermiform appendix. *Habnemannian Monthly*, 81: 230, 1946.
13. LeBrun, H. I. Adenocarcinoma of the appendix. *J. Internat. Coll. Surgeons*, 20: 481, 1953.
14. Crile, G., Jr. and Glenn, C. G. Primary adenocarcinoma of the appendix with development of a mucus fistula. *U. S. Nav. Med. Bull.*, 47: 328, 1947.
15. Lesnick, G. and Miller, D. Adenocarcinoma of the appendix. *Cancer*, 2: 18, 1949.
16. Lawton, S. E. and Ehrlich, R. W. Primary adenocarcinoma of the appendix. *J. A. M. A.*, 150: 189, 1952.
17. Woolner, L. B. Carcinoma of the appendix. Comments on pathology. *Proc. Staff Meet., Mayo Clin.*, 28: 17, 1953.
18. Botsford, T. W., Jaques, W. E. and Claus, R. Primary tumors of the vermiform appendix. Clinicopathologic approach. *Am. Surgeon*, 20: 585, 1954.
19. Vance, C. A. Primary carcinoma of the vermiform appendix. *Am. J. Surg.*, 24: 854, 1934.
20. Hilsabeck, J. R. Carcinoma of the appendix. Analysis of a series of cases. *Proc. Staff Meet., Mayo Clin.*, 28: 11, 1953.
21. Schuldt, F. C. Primary adenocarcinoma of the appendix and carcinoid tumors. *Minnesota Med.*, 23: 791, 1940.

One-Stage Reconstruction of the Abdominal Wall

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THIS is the report of a case of recurrent carcinoma of the transverse colon with direct invasion of the anterior abdominal wall, including the skin. It is believed that description of the technic of reconstruction of a large through and through defect of the abdominal wall, performed in one stage, warrants a report. A search of the literature has failed to reveal a similar technic.

FIG. 1. Preoperative appearance of carcinoma of abdominal wall.

REPORT OF CASE

L. B., a forty-nine year old white male steel mill worker, was admitted to Aspinwall Veterans Administration Hospital on April 15, 1952 with the complaint of an abdominal tumor.

In 1943, while in the armed service, the patient had an operation on the colon for a tumor. Postoperatively he did well, gaining 49 pounds and having no digestive disturbances. In 1950, he began to lose weight (45 pounds from 1950 to 1952) and to have abdominal cramps. He began to vomit and noticed a lump beginning to form in the incision.

Physical examination revealed a well developed but poorly nourished man of about fifty years of age. There was a rectus scar on the upper right portion of the abdomen around and through which had grown a firm mass measuring about 15 cm. in diameter and extending 7 cm. above the level of the skin. (Fig. 1.) The skin over the tumor was warm and red and there was a small fluctuant area in the center. A large intraabdominal mass, definitely and firmly attached to the skin, was easily palpable. The entire mass could be moved freely and apparently was not deeply attached within the abdomen. The liver was not palpable.

FIG. 2. Barium enema showing obstruction of the colon by tumor.

FIG. 3. Defect of the abdominal wall following resection of the tumor.

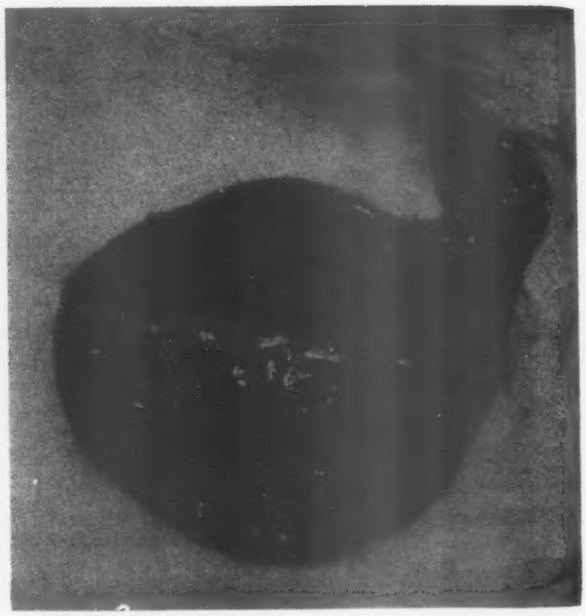

FIG. 4. Insertion of tantalum mesh over the liver and intestines.

FIG. 5. Shifting of adjacent pedicle flap over the tantalum.

The red blood cell count on April 15, 1952, the day of admission, was 2,930,000 per cu. mm. Multiple blood transfusions brought the red blood cell count to 4,370,000 per cu. mm. on April 25, 1952. A routine roentgenogram of the chest was negative for metastases. A barium enema performed on April 21, 1952 (Fig. 2) was interpreted as showing changes in the transverse colon consistent with the diagnosis of carcinoma at the former anastomotic site in the mid-portion of the transverse colon. The remaining portion of the large bowel showed no evidence of disease.

The patient received eleven units of blood from April 22, 1952 to April 30, 1952. On April 25, 1952, in preparation for intestinal surgery, the patient was treated with sulfasuxidine® and aureomycin. Surgery was deemed feasible since the area involved was considered resectable.

The operation consisted of a wide *en bloc* resection of the full thickness of the abdominal wall, which extended over most of the right

upper quadrant and portions of the other quadrants including the umbilicus. (Fig. 3.) A right colectomy, including 20 cm. of terminal ileum, together with the mesenteric roots of the colon and terminal ileum was performed. Primary repair of the defect was by insertion of a large sheet of tantalum mesh over the intestines and liver (Fig. 4) over which was rotated a huge adjacent pedicle flap graft from the right anterior chest wall with application of a split skin graft from the left thigh to the surgical defect in the chest wall. (Fig. 5.)

Under general anesthesia, the entire anterior chest, abdomen and left thigh were prepared and draped. The area of the abdomen to be resected was carefully marked so as to leave an adequate margin of uninvolved tissue on the resected specimen. This area was then incised at right angles to the skin, and the abdomen opened. Intra-abdominal exploration revealed no metastases in the liver, and only moderately enlarged mesenteric nodes. The tumor was invading the abdominal wall from the transverse colon, but the colon was entirely free and resectable. A colectomy and ileotransverse colostomy were performed. A large sheet of tantalum mesh was sutured with No. 000 chromic catgut sutures into the abdominal defect, immediately over the right and left lobes of the liver and intestines. A pedicle flap 9 inches long and 6 inches at the base was then outlined on the right anterior and lateral chest wall adjacent to the surgical defect and cut. This pedicle was based on the right flank and was limited to its location because of a previous McBurney incision. The pedicle was raised and rotated inferiorly over the previously described defect of the abdominal wall and directly over the tantalum mesh. A split-thickness dermatome skin graft was then taken from the left thigh. The skin graft was inserted into the defect of the anterior chest wall, and pressure over the graft was obtained by tying over a bolus of gauze. Fluffed gauze was placed over the pedicle, protecting a large dog-ear at the right lateral inferior portion of the pedicle, and a compression dressing was applied to the abdomen and chest wall. The patient withstood the procedure well.

The patient made a remarkably smooth and rapid recovery. At no time during his postoperative period did he experience any undue discomfort. There was no abdominal distention or vomiting. The patient promptly and spontaneously began having normal bowel movements. Fever was minimal and there was no local infection. There were minimal collections of serosanguineous material beneath the pedicle which were aspirated on two separate occasions. The patient was ambulated after two weeks, following application of a secure abdominal support. The patient was kept as a hospital patient until June 20, 1952 so that he could be carefully observed for any development of postoperative complications. The patient was discharged on June 20, 1952.

FIG. 6. Appearance of patient six months following reconstruction of the abdominal wall.

The patient remained clinically free of local recurrence of his cancer and was asymptomatic for six months. No marked relaxation of the anterior abdominal wall could be demonstrated and the patient did not find it necessary to wear any type of abdominal support. (Fig. 6.)

Symptoms of obstruction developed again during the winter of 1952 to 1953, and the patient returned to the Veterans' Hospital for examination and treatment in July, 1953. At that time a mass was palpable in the left lower quadrant of the abdomen and there was enlargement of the left inguinal lymph nodes. A plain x-ray film of the abdomen showed the previously inserted tantalum mesh to be present. (Fig. 7.)

At operation in July, 1953, a large obstructing carcinoma was found in the rectosigmoid. The tumor had extended into the mesentery and was fixed to the lateral pelvic wall. There

FIG. 7. Plain film of abdomen showing the previously inserted tantalum mesh gauze.

was gross involvement of numerous intra-abdominal lymph nodes. There were still no metastases in the liver, and the site of the previous intraabdominal operation was not involved with tumor. Since the local extension made it impossible to resect this tumor, a colostomy was performed.

The patient died of carcinoma of the rectosigmoid on May 15, 1954, nearly two years after the one-stage reconstruction of the abdominal wall and eleven years after the first colonic resection. At autopsy it was demonstrated that death was due to a primary rectosigmoid cancer which apparently had no relation to the previous cancer of the transverse colon.

SUMMARY AND CONCLUSIONS

A case of recurrent carcinoma of the transverse colon with direct extension into all layers of approximately one-third of the anterior abdominal wall is presented.

A method of surgical treatment by wide local resection of the involved abdominal wall and intestine together with a technic of immediate one stage repair of the abdominal wall defect by tantalum mesh and local pedicle flap coverage is described.

REFERENCES

1. GREENE, D. D., THOMAS, S. S., JR. and THOMPSON, J. M. Onlay tantalum mesh, and emergency replacement of an abdominal wall defect. *U.S. Armed Forces M. J.*, 3: 1529–1534, 1952.
2. LAM, C. R., SZELOGYI, D. D. and PUPPENDAHP, M. Tantalum gauze in repair of large postoperative ventral hernias. *Arch. Surg.*, 57: 234–244; 1948.
3. GUTHRIE, D., CLOUGH, D. M. and BECK, W. C. Tantalum mesh gauze in repair of ventral hernias. *Gutbrie Clin. Bull.*, 19: 175–180, 1950.
4. BUSSABARGER, R. A., DUMOUCHEL, M. L. and IVY, W. H. Use of tantalum mesh to repair a large surgical defect in the anterior abdominal wall. *J. A. M. A.*, 142: 984–985, 1950.
5. KOONTZ, A. R. Repair of surgical abdominal defect with tantalum mesh. *J. A. M. A.*, 148: 460–461, 1952.
6. KOONTZ, A. R. and KIMBERLY, R. C. Tissue reaction to tantalum mesh and wire. *Ann. Surg.*, 131: 666–686, 1950.
7. CRILE, G., JR. and KING, D. E. Successful use of tantalum mesh to repair an abdominal wall defect in the presence of massive fecal contamination. *Surgery*, 29: 914–916, 1951.
8. STRONG, G. H. Repair of large abdominal defects following cystectomy for congenital vesical exstrophy, a new technique. *J. Urol.*, 64: 743–746, 1950.
9. LESNICK, G. J. and DAVIDS, A. M. Repair of surgical abdominal wall defect with a pedicled musculofacial flap. *Ann. Surg.*, 137: 569–572, 1953.
10. THROCKMORTON, T. D. Tantalum gauze in the repair of hernias complicated by tissue deficiency. *Surgery*, 23: 32–46, 1948.
11. FLYNN, W. J., BRANT, A. E. and NELSON, G. C. A four and one-half year analysis of tantalum gauze used in the repair of ventral hernia. *Ann. Surg.*, 134: 1027–1034, 1951.
12. COKKINI, A. J. and BROMWICH, A. F. Tantalum repair of very large incisional hernia healing after secondary repair. *Brit. J. Surg.*, 41: 623–624, 1954.
13. KOONTZ, A. R. and KIMBERLY, R. C. An evaluation of the usefulness of fortisan fabric in hernia repair. *Ann. Surg.*, 139: 644–649, 1954.

Retrocecal Hernia

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IN retrocecal hernia an abdominal hollow viscus extends into a loculation of the peritoneum and lies behind the cecum. Although different explanations for the formation of a retrocecal peritoneal pouch have been advanced, the exact mechanism remains obscure.

According to Hansman and Morton [2], the only supports for the peritoneal reflections are the parietes, the vessels and the nerves. They thought that a hernia could occur at any point where the peritoneum was not defended by these structures. These authors also believed that fossa and hernia were expressions of regional peritoneal weakness rather than that the fossa acted as an etiologic agent in the formation of the hernia. According to this view, a retrocecal hernia could form when an abdominal hollow viscus exerted pressure on subcecal peritoneum which was not supported properly. The terminal ileum could insinuate itself into an expanding pouch of peritoneum between the cecum and the posterior wall of the abdomen. The pathogenesis in this instance would be similar to that of a direct inguinal hernia.

Another concept of etiology is that reported by Mayo, Stalker and one of us (J. M. M.) [4]. It was stated that improper fusion of the peritoneal layers of the postarterial segment of the primary midgut loop will result in the formation of small pouches under the cecum and the ascending part of the colon.

According to Arey [1], in embryologic development the large intestine, perhaps because of its cecal swelling, is the last to leave the umbilical cord and return to the abdominal cavity. If the cecum were adherent to the peritoneal sac within the umbilical stalk, upon its return to the abdominal cavity, it could bring with it a part of this peritoneal sac as the retrocecal pouch. The occurrence of retroperitoneal hernias in newborn infants could be explained on this basis. The pathogenesis in this instance would be similar to that of an indirect inguinal hernia.

Moynihan [5] adopted the name, retrocolic, as the term for the fossa. To see the pouch the cecum must be turned upward. A fossa of variable size and capacity is situated behind the cecum and the lower part of the ascending colon. In some cases the whole length of the index finger can be comfortably laid in a peritoneal tube which extends upward to the kidney. In others there may be a narrow and shallow dimple that would contain the tip of a lead pencil. Between these two extremes any size may be observed. The fossa is bounded and determined by two peritoneal folds, an outer and upper, and a lower and inner.

Moynihan [5] found fourteen cases of retrocolic hernia but accepted only seven as true retrocecal hernia. Langley [3], after reviewing the literature, stated that twenty-six cases of intestinal obstruction due to pericecal hernia were reported. Hansman and Morton [2] found thirty-one pericecal hernias in a total of 467 intra-abdominal hernias, for an incidence of about 7 per cent. Mayo, Stalker and one of us (J. M. M.) [4] reported two retrocecal hernias in thirty-nine instances of intra-abdominal hernia treated surgically, for an incidence of about 5 per cent. Of nine internal hernias reported by Wangensteen [6], there were two pericecal hernias, or an incidence of about 22 per cent.

Retrocecal hernias have been found as incidental findings during the performance of operations for other conditions in patients who have not had symptoms attributable to the hernias. When a loop of small intestine becomes constricted at the aperture of the sac, the pa-

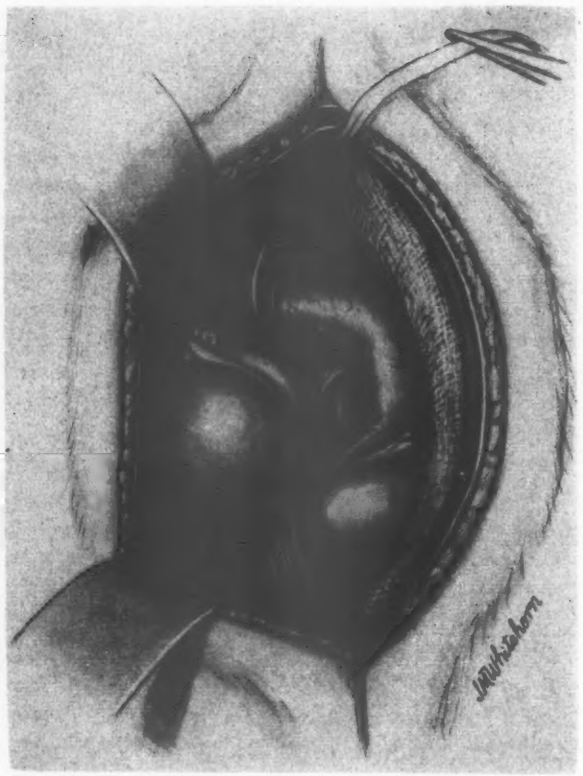

FIG. 1. Retrocecal hernia as seen at the time of the operation.

tient may have signs and symptoms of acute intestinal obstruction, depending upon the degree of constriction. If the obstruction progresses, the segment of small intestine within the hernial sac can become necrotic because of strangulation of its mesentery.

If internal hernias did not become manifest through partial or complete interruption of the continuity of the intestinal lumen, the majority of such hernias would pass without recognition, for they are unheard of until their presence is heralded by some complication such as incarceration, volvulus or strangulation. Although few in number, these hernias are important because of the high incidence of intestinal obstruction with which they are associated. These hernias frequently produce symptoms which are bizarre and not characteristic. The diagnosis of the hernia may be missed and the early recognition of obstruction of the intestine may be overlooked. Because strangulation occurs in many patients with symptomatic internal hernia, immediate surgical treatment is indicated.

Treatment of retrocecal hernia consists of reduction of the herniated mass followed by suture of the orifice. When strangulation has occurred, with irreversible changes in the small intestine, resection of the affected segment followed by anastomosis of the viable ends is necessary.

CASE REPORT

A sixty year old white man was admitted to the hospital on September 18, 1955, with a history of having frequently repeated episodes of crampy pain in the lower part of the abdomen for about twelve hours. The pain localized in the right lower quadrant and became more severe in nature. Nausea and three bouts of vomiting of non-sanguineous material occurred. The patient took a laxative and had several watery stools which did not contain blood. Similar attacks had not occurred previously. Bilateral inguinal herniorrhaphy had been performed in 1928 and appendectomy in 1930.

The patient was well developed, well nourished, and moderately acutely ill. His temperature was 97.6°F.; pulse rate, 74 per minute; respiratory rate, 18 per minute; and blood pressure, 140/90. The abdomen was flat and had a normal contour. There was an oblique scar in the right lower quadrant of the abdomen and scars in both inguinal regions. A moderate degree of direct tenderness and rigidity of the muscles were noted in both lower quadrants of the abdomen with rebound tenderness in the right. Palpable viscera and masses were not present in the abdomen. High pitched gurgling borborygmi associated with the height of the individual attacks of pain were heard in the right lower quadrant of the abdomen.

The hemoglobin was 13.2 gm. per 100 cc. and the white blood cell count was 14,400 per cu. mm. with 90 per cent polymorphonuclear neutrophilic leukocytes, 9 per cent lymphocytes and 1 per cent monocytes. The bleeding time and the coagulation time were normal. The serum amylase was 92 Somogyi units per 100 cc. Urinalysis was normal except for the presence of ten to twelve red blood cells per high power field. The roentgenogram of the chest was normal. The scout films of the abdomen with the patient in the supine and the erect positions showed several moderately dilated loops of small intestine without fluid levels.

A diagnosis of early intestinal obstruction

due to postoperative adhesions was made. A Levin tube was inserted into the stomach and continuous suction applied. A urethral catheter was placed into the bladder. Penicillin and streptomycin were given intramuscularly. Fluids were administered intravenously.

Laparotomy was performed through a paramedian incision in the right lower quadrant of the abdomen. Upon incising the peritoneum, several slightly distended loops of ileum were seen. The small intestine was followed distally until it entered a peritoneal sac behind the cecum. (Fig. 1.) With gentle traction about 20 cm. of distal ileum were withdrawn from the pouch. A small hematoma was present in the mesentery of this part of the ileum but the small intestine was normal. A small Meckel's diverticulum was found about 6 cm. proximal to the herniated segment of ileum and about 36 cm. from the ileocecal valve. The sac behind the cecum was closed with interrupted sutures of No. 00 atraumatic® chromic catgut. The Meckel's diverticulum was removed and the ileum was closed in two layers. The abdomen was closed in layers.

The postoperative course was uneventful and the patient was discharged from the hospital on October 3, 1955.

SUMMARY

The pathogenesis, incidence and treatment of retrocecal hernias are discussed. The successful management of a patient with a retrocecal hernia is reported.

REFERENCES

1. Arey, L. B. Developmental Anatomy. A Textbook and Laboratory Manual of Embryology, 5th ed. Philadelphia and London, 1946. W. B. Saunders Co.
2. Hansman, G. H. and Morton, S. A. Intra-abdominal hernia. Report of a case and review of the literature. *Arch. Surg.*, 39: 973–986, 1939.
3. Langley, G. F. Strangulated internal hernia. Report of cases of strangulation in the fossa iliaco-subfascialis and through the foramen of Winslow. *Brit. J. Surg.*, 23: 119–127, 1935–1936.
4. Mayo, C. W., Stalker, L. K. and Miller, J. M. Intra-abdominal hernia—review of thirty-nine cases in which treatment was surgical. *Ann. Surg.*, 114: 875–885, 1941.
5. Moynihan, B. G. A. On retroperitoneal hernia. Being the "Arris and Gale" lectures on "The anatomy and surgery of the peritoneal fossae" delivered at the Royal College of Surgeons in 1897, 2nd ed. London, 1906. Bailliere, Tindall and Cox.
6. Wangensteen, O. H. Intestinal Obstructions. Physiological, Pathological and Clinical Considerations with Emphasis on Therapy, Including Descrpition of Operative Procedures, 3rd ed. Springfield, Ill., 1955. Charles C Thomas.

A Swelling of the Round Ligament Resembling an Acutely Incarcerated Inguinal Hernia

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SWELLING of the round ligament simulating an acutely incarcerated inguinal hernia is an unusual occurrence. Since no report of a similar case has been found in an extensive search of the literature, it is believed that this unusual surgical condition merits reporting.

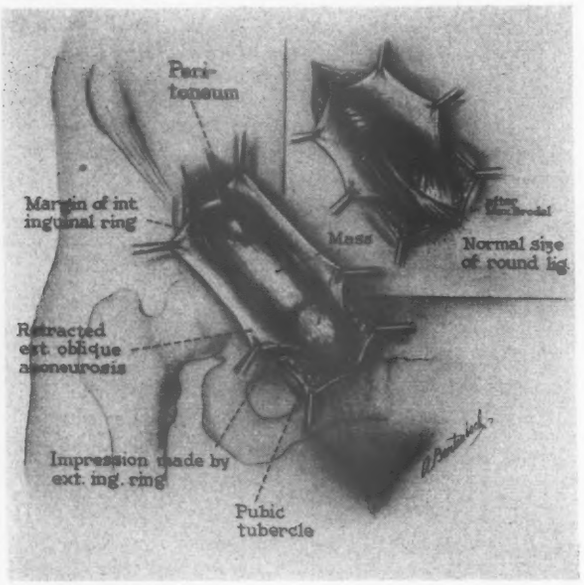


FIG. 1. Right inguinal region at operation. The swollen round ligament and hernial sac have been exposed by an incision through the external oblique aponeurosis. The normal appearance of the inguinal region is shown in the insert.

CASE REPORT

E. B., a thirty-nine year old white housewife had a swelling in the right inguinal region since her first confinement in 1950 which was classified as a small symptomless inguinal hernia. She was hospitalized on June 19, 1954 and delivered a 7 pound 12 ounce boy without incident. She was dismissed after five days of a normal puerperium. A few hours after dismissal the swelling in the right groin suddenly became enlarged and very painful. Because of her record she was readmitted to the hospital with the tentative diagnosis of an incarcerated hernia. The pain was persistent and there was no nausea or vomiting.

The physical examination was normal except for the findings in the right groin. A tender, discrete ovoid mass, 6 cm. in greatest dimension with the long axis parallel to the inguinal ligament, protruded from the region of the external ring. Attempts to reduce the mass were soon abandoned because of marked tenderness.

At operation, five hours after the symptoms appeared, a pale gray firm mass was found protruding from the external ring. The aponeurosis of the external oblique muscle was divided parallel to the inguinal ligament, uncovering the entire mass which measured 8 cm. by 3 cm. by 3 cm. The mass extended into the internal inguinal ring and was held by tenuous attachments to the pectineal fascia and the subcutaneous layer of the pudendum. It was identified as an edematous enlargement of the round ligament and sheath. (Fig. 1.) The swollen ligament was freed and retracted laterally. There was no evidence of a hernial sac but only a small peritoneal fold at the internal inguinal ring, 2 cm. long when held taut. This was easily dissected from the ligament, opened, found to be empty and closed at the level of the internal ring. The edematous round ligament was divided at the same level and the distal portion

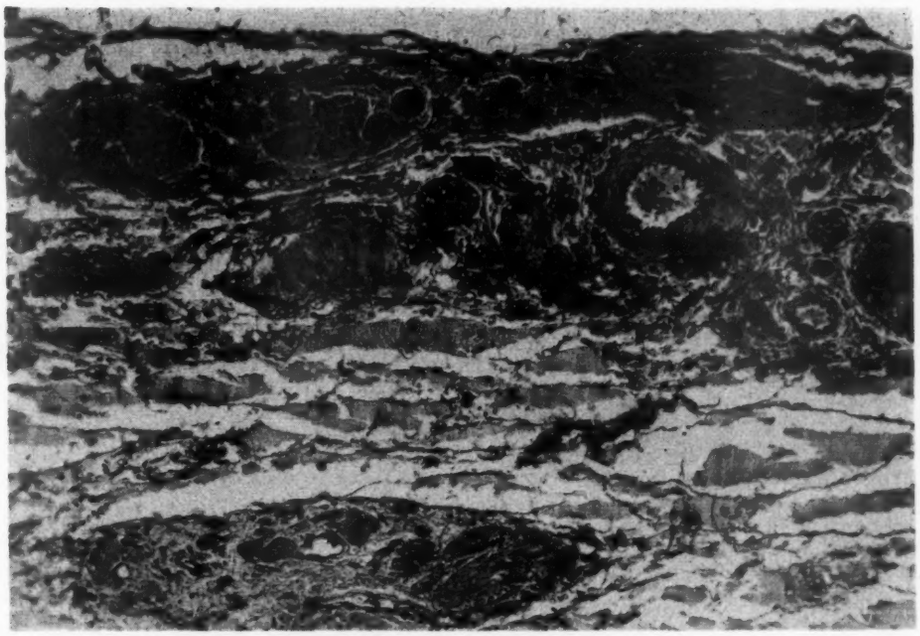


FIG. 2A. Microscopic appearance of section through the round ligament. Note the edema fluid beneath the surface, the infiltration with inflammatory cells and separation of the connective tissue and smooth muscle fibers by pools of fluid. Original magnification × 160.

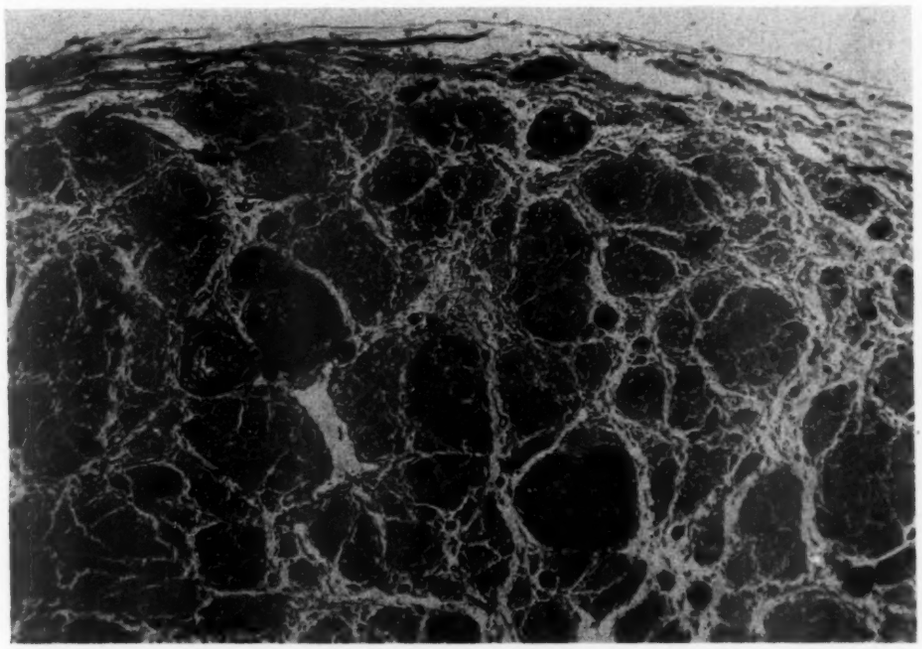


FIG. 2B. Microscopic section through a normal round ligament from the canal of Nuck in a woman of the same age. Original magnification × 160.

was removed. The internal ring was obliterated and the remaining steps of a hernia repair completed. The postoperative course was uneventful and the patient was discharged on the fifth postoperative day.

The microscopic examination of the specimen showed an acute inflammatory reaction principally in the outer layers of the round ligament. The surface was diffusely coated with an exudate composed of abundant fibrin and a

moderate number of polymorphonuclear neutrophils. In a few areas there were small foci of granulation tissue and groups of decidual cells. The remaining tissue was edematous for the connective tissue and smooth muscle fibers were separated by amorphous and fibrillary material forming pools of fluid. Scattered groups of lymphatics within this zone were dilated. (Fig. 2.)

COMMENT

At operation there was no sign of sepsis, necrosis, neoplasm, aberrant sex organs or rudimentary tissue. The acute swelling seems to have been indicative of beginning strangulation associated with venous and lymphatic obstruction plus early inflammatory changes. There does not appear to be any specific factor in the postpartum status to explain this condition.

In retrospect it would seem that this swelling, which was assumed to be a small inguinal hernia for four years, was probably a chronic enlargement of the round ligament and its true nature did not become evident until acute symptoms required surgical intervention.

The acute phase of this case has many features similar to acute torsion of the spermatic cord which may resemble an incarcerated inguinal hernia, particularly when the torsion occurs in association with an undescended testis. When the testis is in this position it is more liable to be affected by torsion than one which rests in the scrotum [1]. The most common exciting factor in torsion is thought to be any movement which induces a strong contraction of the cremasteric muscle [2]. This phenomenon might have produced constriction of the round ligament in this case, resulting in venous engorgement and edema. Spasm of the cremasteric muscle alone can produce severe pain in men [3].

CONCLUSION

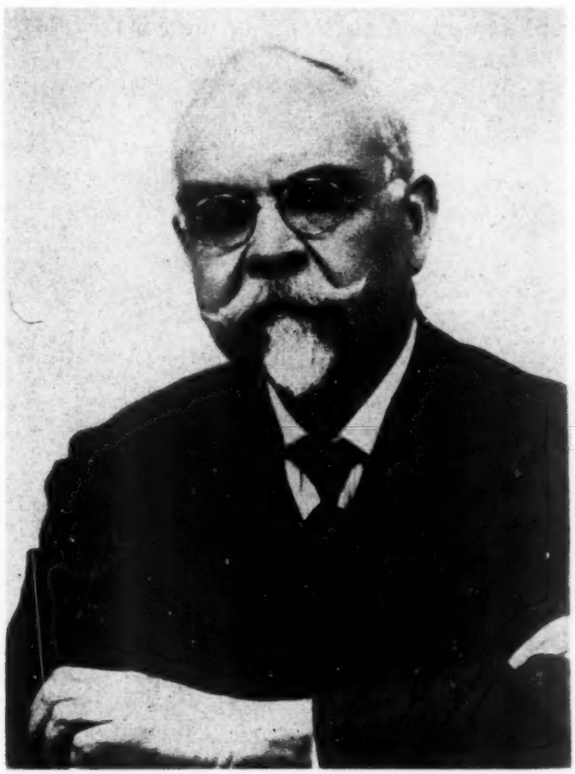
A case in which a swelling of the round ligament prompted a preoperative diagnosis of an acutely incarcerated inguinal hernia is reported. No report of a similar case is found in the literature. The pathogenesis of this condition remains obscure.

REFERENCES

1. Ormand, J. K. Torsion of the testicle. *J. A. M. A.*, 111: 1910, 1938.
2. Peck, S. Torsion of the spermatic cord. *J. Urol.*, 62: 701, 1949.
3. Muschat, M. Cremasteric spasm. *Arch. Surg.*, 43: 609, 1941.

IN MEMORIAM

Rudolph Matas, M.D., LL.D., F.A.C.S.
September 12, 1860–September 23, 1957



Doctor Rudolph Matas, world-famed surgeon, teacher, and pioneer in his calling, especially in vascular surgery, died on September 23, 1957, eleven days after reaching the age of ninety-seven. For the past few years he had ceased active work, mainly because of failing eyesight, but with secretarial aid had continued writing. He was renowned in every civilized country on earth. He travelled extensively and was welcomed in the leading medical centers at home and abroad. Many countries have honored him. His life and achievements occupy a column of fine print in "Who's Who in America." He studied in Paris, France, and Barcelona, Spain. He received his medical degree from Tulane University, New Orleans, Louisiana, where for several decades he was Professor of Surgery. A plaque placed in his honor in Touro Infirmary of New Orleans, where he spent thirty

years as Chief of Surgery, represented another unusual honor to a living physician.

Doctor Matas' service on the Editorial Board of *The American Journal of Surgery* was the longest of any member; he had been on the Board for many years when we become Editor thirty years ago. He was a contributor of articles and monographs. He always answered a request. His advice and counsel were eagerly sought and followed.

A tireless worker, Doctor Matas was called "a glutton for work." Doctor William Mayo once called him "the most learned surgeon I have ever known." Beyond his scientific prowess, his was a charming personality. Truly he was a *bon vivant*, a perfect host, an entertaining table companion. To his countless friends he typified the perfect gentleman, scholar and ideal Doctor of Medicine. With his passing we have lost the last great pioneer surgeon of an era of outstanding surgeons.

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1. Axelrod, A. E.; Beaton, J. R.; Cannon, P. R., and others: Symposium on Protein Metabolism, New York, The National Vitamin Foundation, Incorporated, (March) 1954, p. 100.

2. Proceedings of a Conference on the Clinical Use of Anabolic Agents, Chicago, Illinois, G. D. Searle & Co., April 9, 1956, pp. 32-35.

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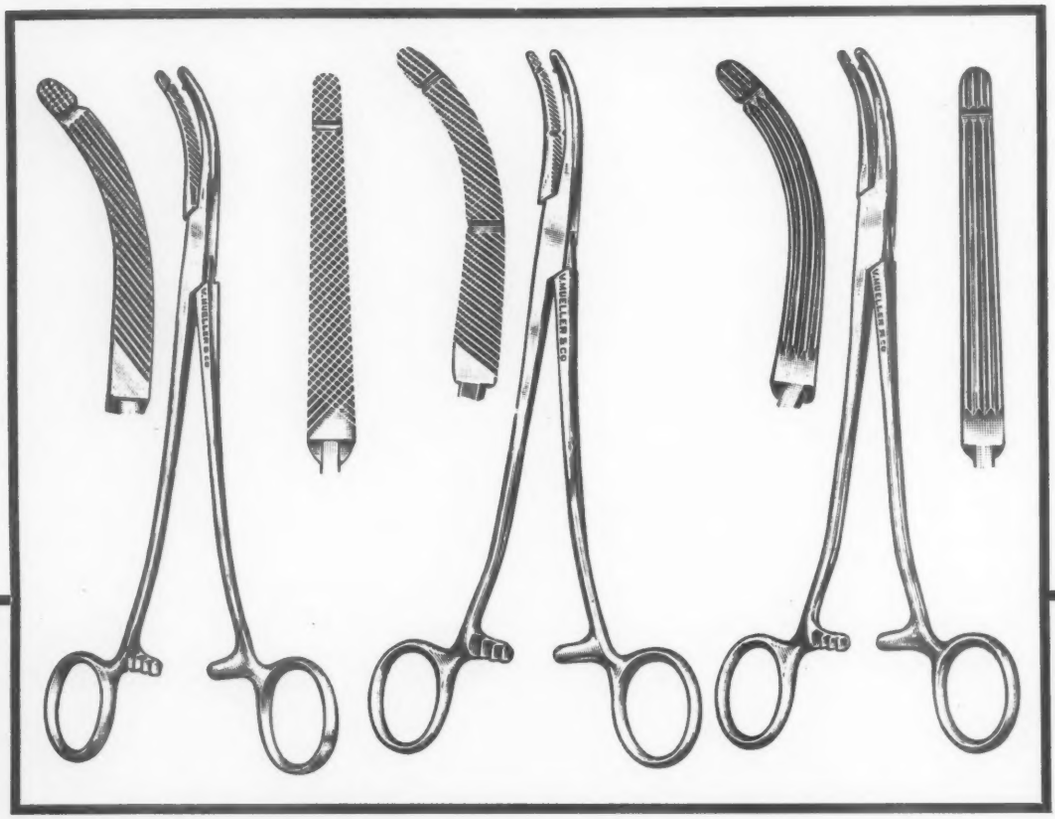

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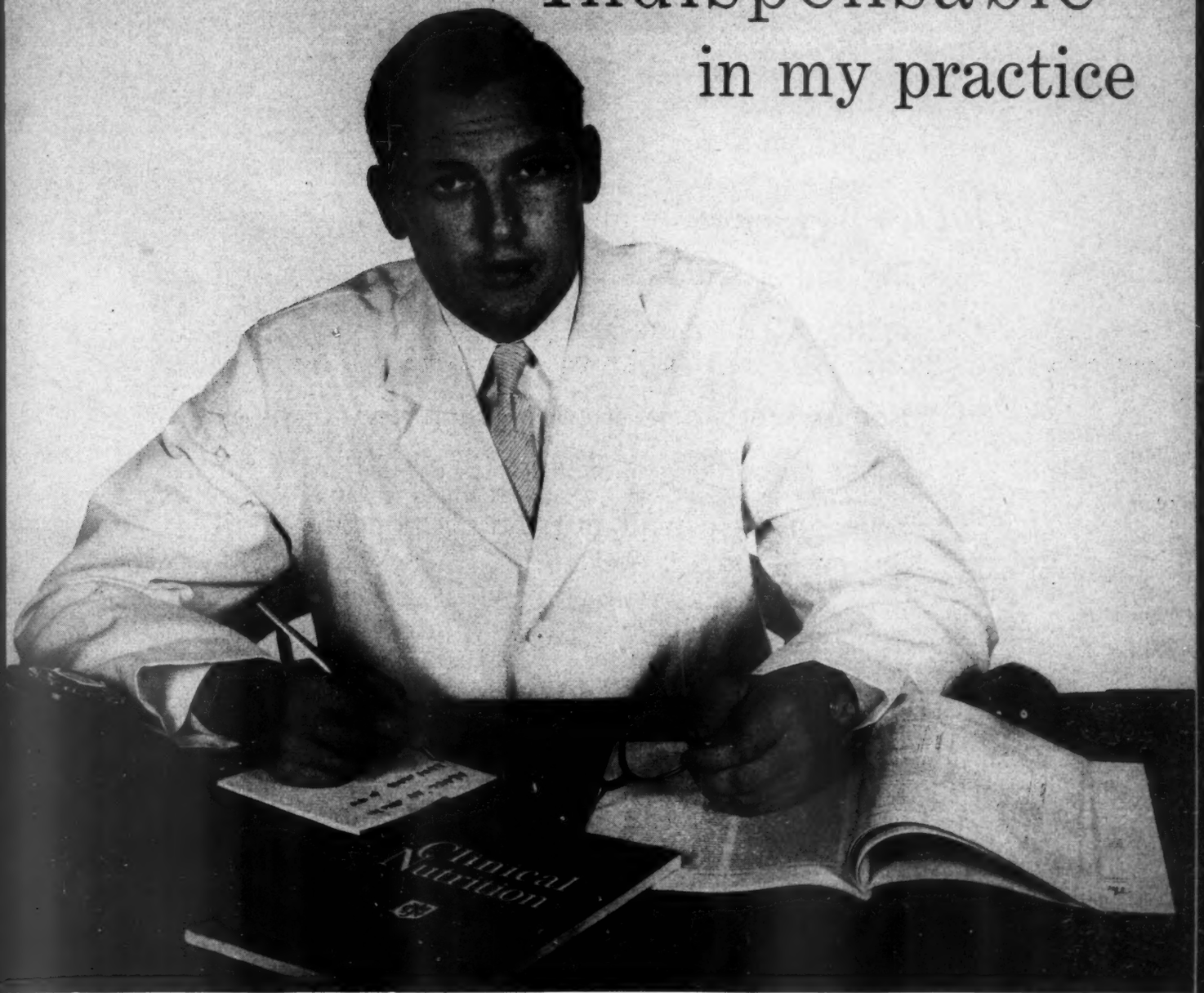

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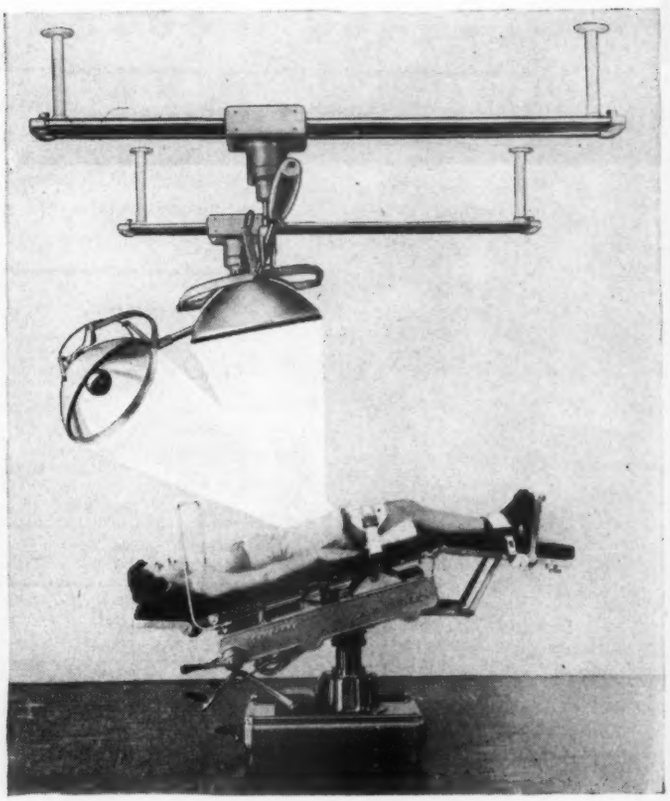

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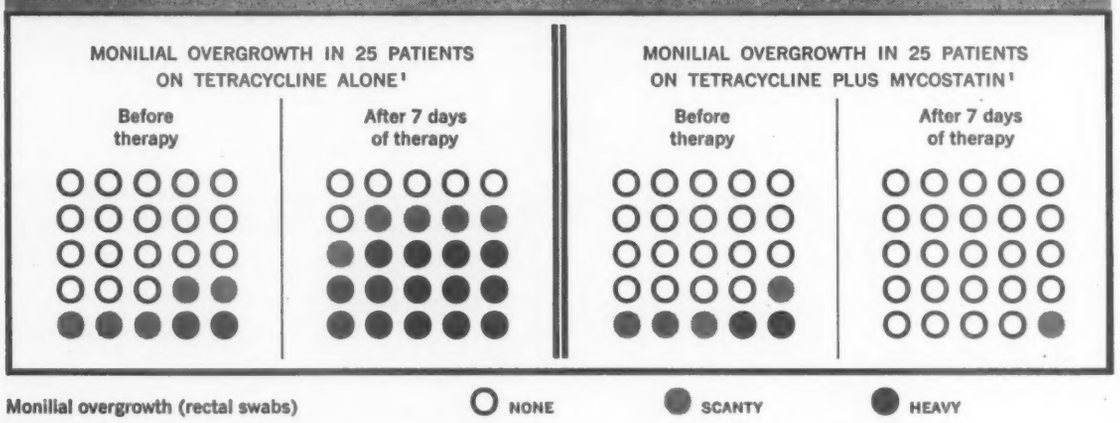

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1. Childs, A. J.: British M. J. 1:660 (March) 1956.

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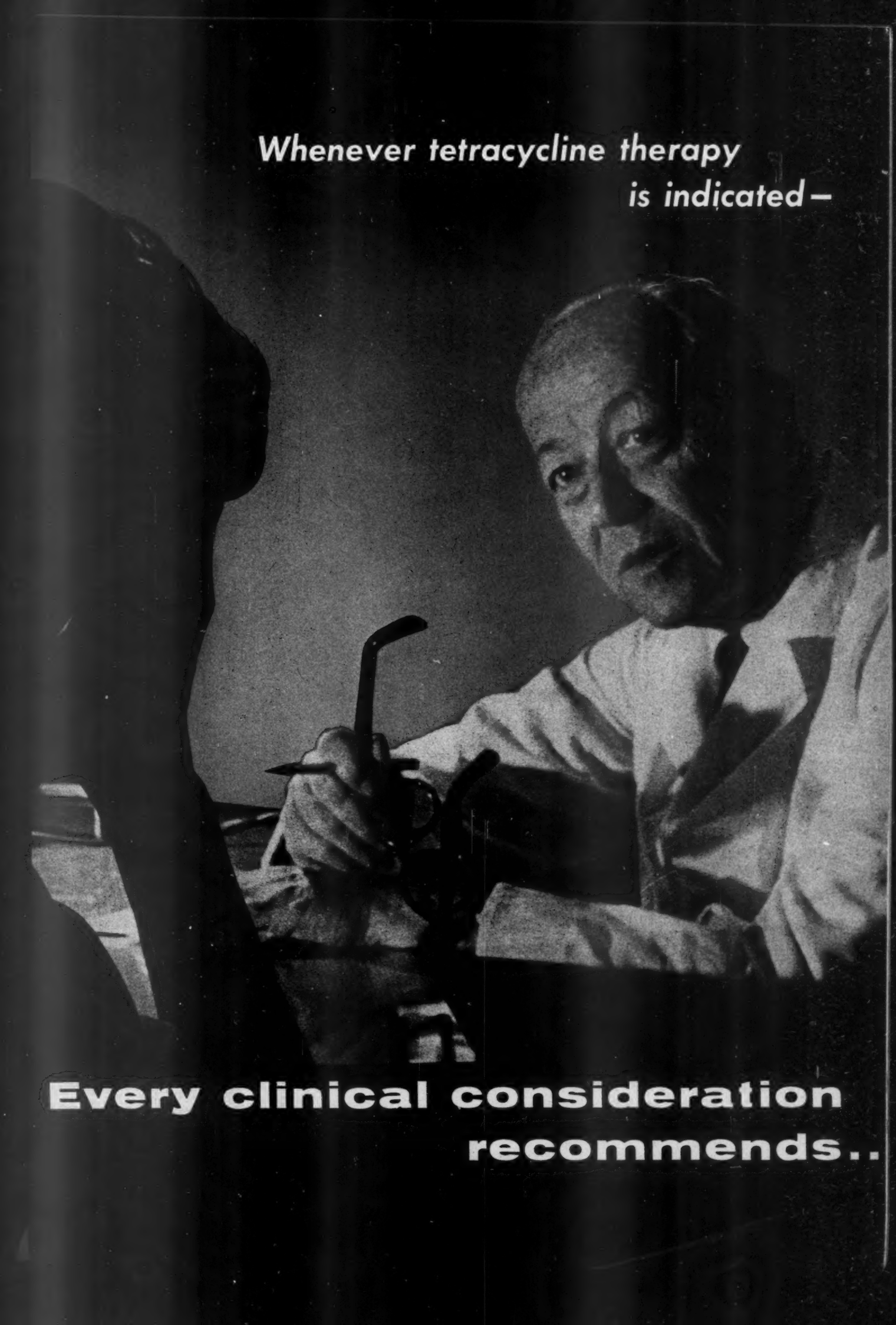
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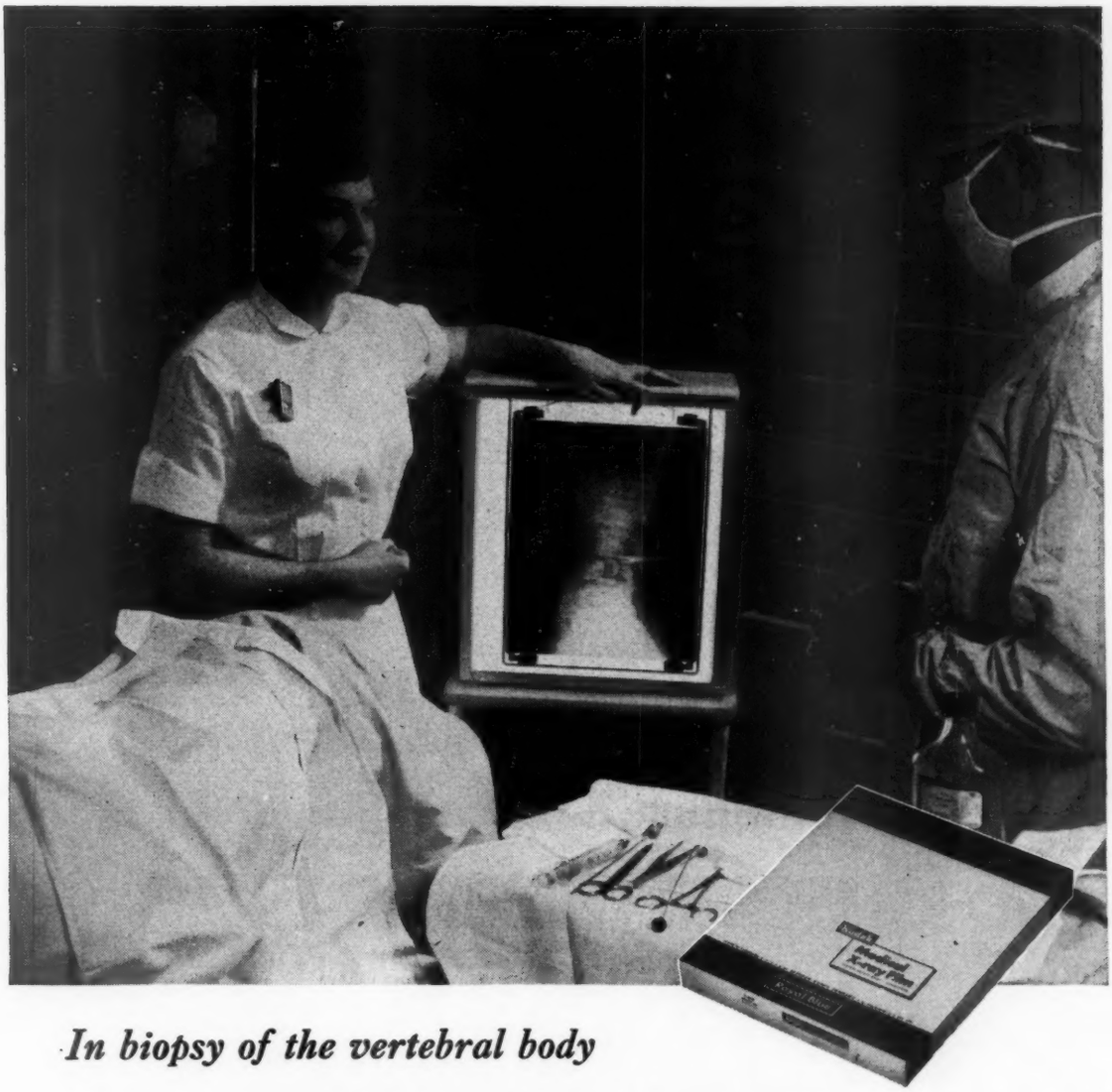

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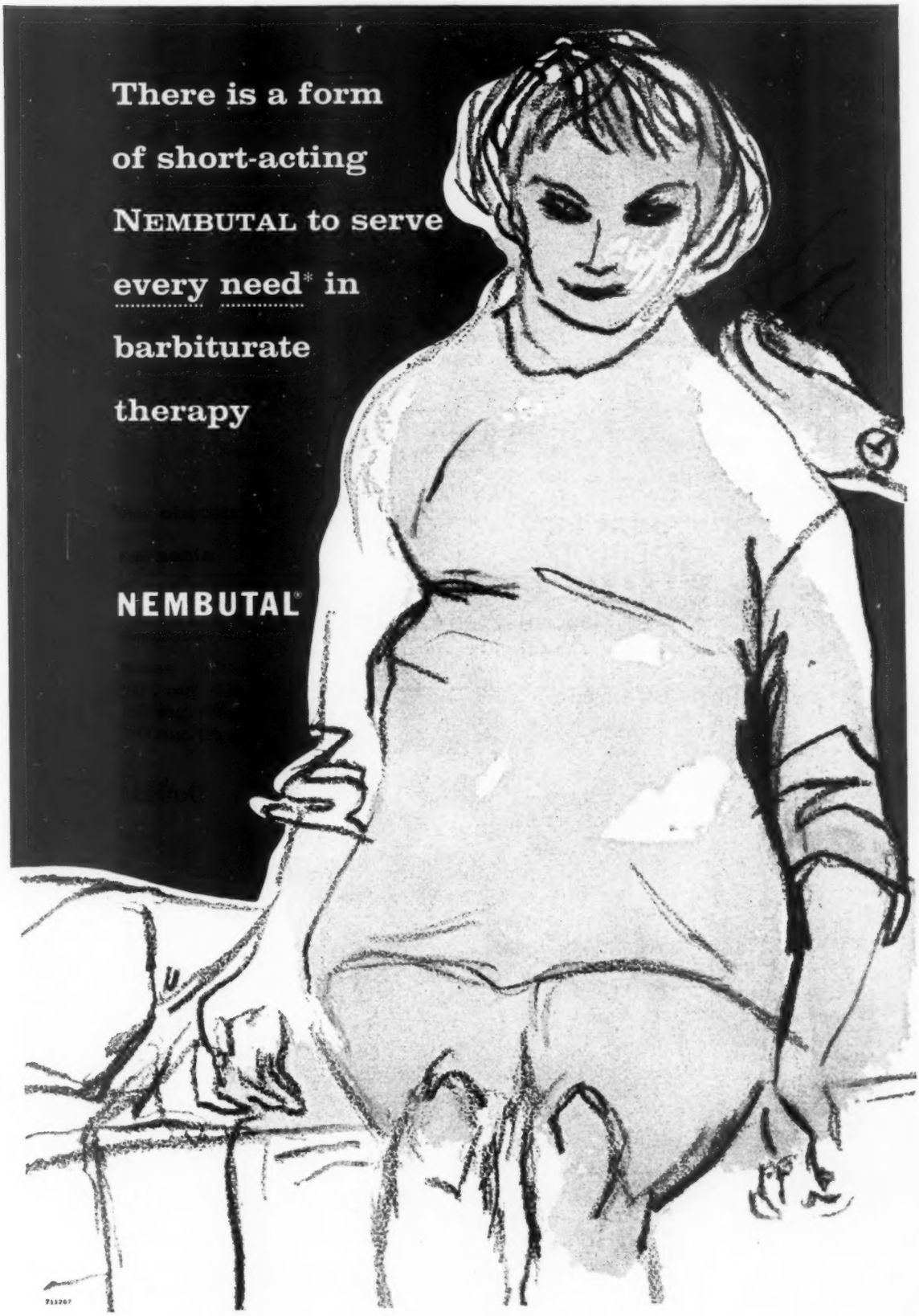
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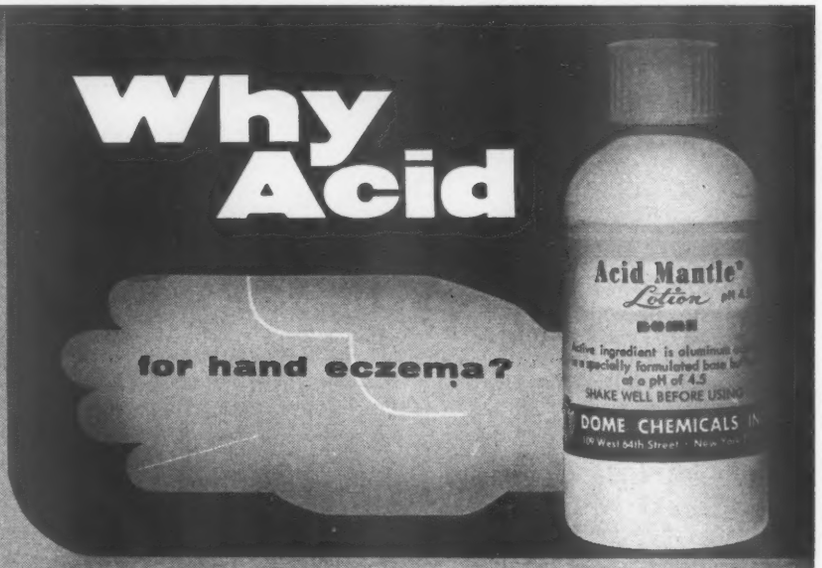

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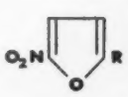

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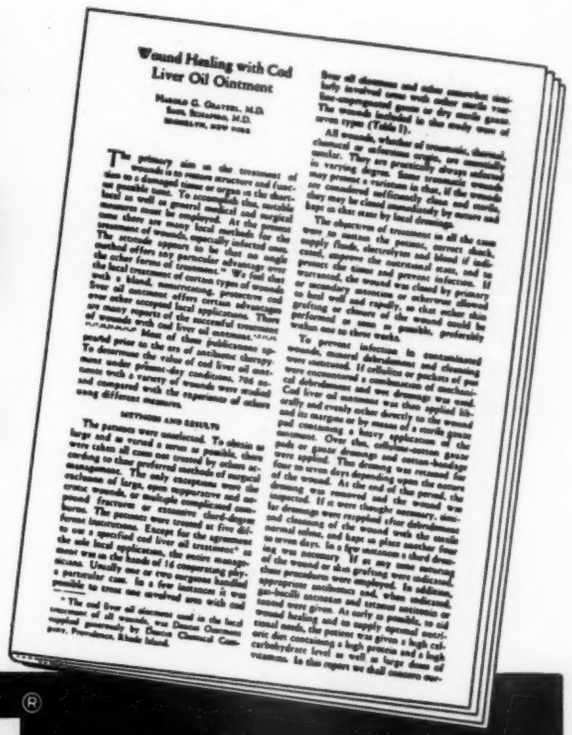
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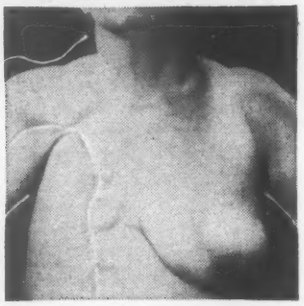

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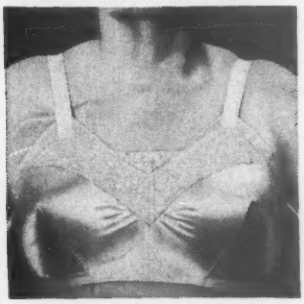

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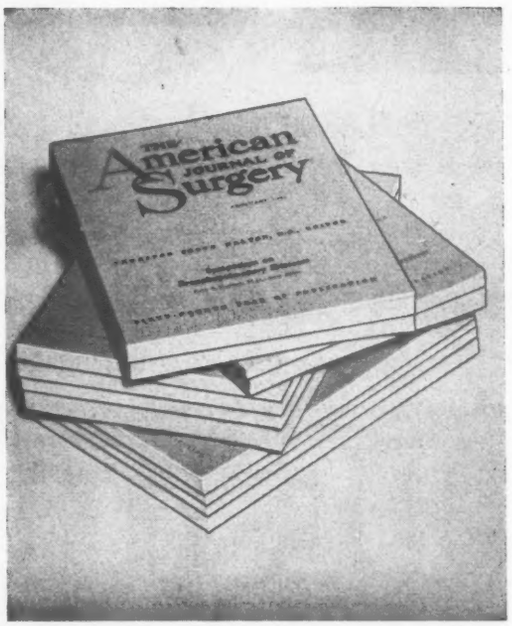

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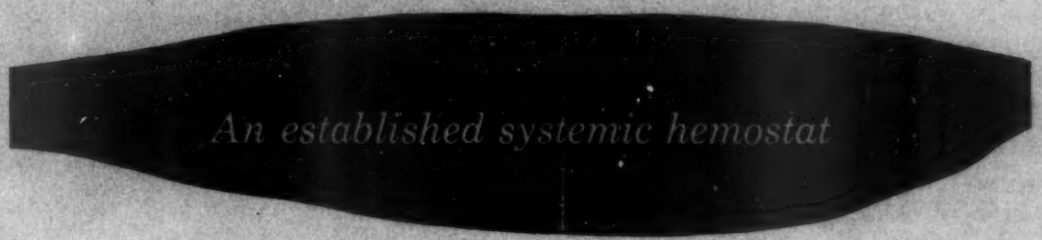

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1. Riddle, A.C., Jr.: Adrenosem Salicylate: A Systemic Hemostat, Oral Surg., Oral Med., Oral Path. 6:617 (June, 1955).

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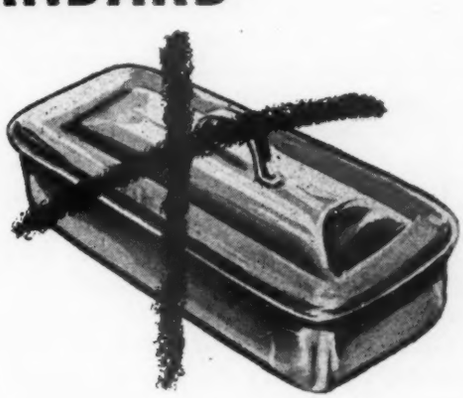

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NOTES AND QUOTES

To help communities to cope with new and changing health problems, including those of the nuclear age, the American Public Health Association is initiating a long-range technical development program.

The purpose, according to Dr. Reginald M. Atwater, executive secretary, is "to provide leadership, stimulation and guidance to governmental and voluntary agencies in facing health problems of the nuclear age. In some important areas of public health, methods and standards have remained virtually unchanged since the horse-and-buggy era."

Initial concentration will be in eight areas: radiological health, accident prevention, mental health, chronic disease and rehabilitation, child health, environmental health, medical care administration and public health administration.

A committee of experts in each area will develop policy statements, write operating manuals, conduct field studies, surveys and demonstrations, and consult with state and local health authorities and agencies.

A new vaccine to combat "Far East Influenza" has been placed in full-scale production for civilian use by Lederle Laboratories Division, American Cyanamid Company.

The vaccine will be distributed through regular channels when first lots become available. Called Influenza Virus Vaccine–Monovalent Type A Asian Strain, the new product will be packaged in ten immunization (10 cc.) vials.

MEMBERS of the medical profession are invited to attend any of the following 1958 Sectional Meetings of the American College of Surgeons being held in conveniently located cities of the United States, with one supplementary meeting in Sweden. Meeting cities and dates follow: Dallas, Texas, January 9–11; Jackson, Mississippi, January 16–18; New York City, March 3–6; Salt Lake City, Utah, March 17–19; Des Moines, Iowa, March 27–29; Stockholm, Sweden, July 2–7; 44th Annual Clinical Congress, Chicago, Illinois, October 6–10.

All Sectional Meetings draw on surgeons of outstanding ability to discuss problems encountered in daily practice, and to disseminate information about new technics. Usefulness is the keynote to all College programs, which are planned by local committees answering the needs and wishes of doctors within the meeting area. Panels, symposia, papers, medical motion pictures, and question and answer periods characterize the meetings.

Two new features are scheduled for each Sectional Meeting this year: a fellowship luncheon, at which a panel of College officials will answer questions about the entire program of College activities and, in turn, pose questions to the audience; and a social, rather than scientific, dinner meeting, to which program participants, visiting surgeons, wives and other guests are cordially invited for an informal evening of entertainment.

A new method to aid in gastric analysis has been developed which promises to replace the older "tube swallowing" procedures for determining the presence or absence of hydrochloric acid in the stomach. Developed by E. R. Squibb & Sons, the test utilizes the new product, Diagnex Blue, a blue dye–resin indicator.

The Diagnex Blue test has the patient take two tablets of caffeine sodium benzoate, to stimulate gastric secretion, in the fasting state. One hour later the patient takes ¼ glass of water containing granules of blue dye–resin complex. If free hydrochloric acid is present in the stomach, some of the blue dye will be displaced from the complex by hydrogen ions and will appear in a urine sample obtained exactly two hours later. The dye content can be estimated by visual comparison with color standards contained in the Diagnex Blue package.

Among the advantages of this method are its safety, accuracy, simplicity, speed, versatility, economy, and the elimination of the discomforts of intubation. Because of these desirable features, this test lends itself admirably to large scale cancer-screening programs and industrial and insurance surveys, as well as application in private or hospital practice.

A CLINICAL study which indicates that the amino acid lysine may have a direct effect on the secretion of digestive juices in the stomach is reported in the journal *Science* (Vol. 26, No. 3267, p. 255).

The study, by Drs. Arthur M. Sackler and Lawrence H. Sophian of the van Ophuijsen

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Center, New York City, showed that "the addition of five grams of lysine monohydrochloride to a bread and water test meal significantly increased gastric secretion of hydrochloric acid and pepsin, or both, in 18 of 21 subjects . . . "

The physicians suggest that this increased secretion of gastric juices may explain in part results obtained by clinical investigators which showed that lysine helped improve appetite in anorectic patients. They emphasize, however, that any direct pharmacologic effect of lysine would not preclude or compete in importance with the direct participation of this essential amino acid in body protein synthesis.

Lysine, one of the eight essential amino acids —or protein "building blocks"—has been shown to more than double the protein quality of breads and cereals by "balancing out" the natural lysine deficiency of wheat. Growth tests have shown that wheat foods so fortified are comparable in protein value to meat and milk.

In the study of the effect of lysine on gastric secretion, Drs. Sackler and Sophian fed twenty-one normal adults a test meal of bread and water. This was followed a week later by a second such meal, but with the addition of 5 gm. of synthetic lysine—a relatively large amount, about twice the total daily intake. Gastric analyses were taken at fifteen-minute intervals for one hour after eating. These revealed that twelve subjects had significantly increased hydrochloric acid and pepsin secretion after the meal in which lysine was given. Three subjects had increased hydrochloric acid secretion alone, three had increased pepsin secretion alone, and three showed no increase.

The study, which the authors describe as preliminary, was supported by a research grant from E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., in whose laboratories the first commercial synthesis of lysine was developed.

Within not much more than a year after Trudeau Sanatorium at Saranac closed its doors, a second large tuberculosis sanatorium in the Saranac area, Stony Wold, has been brought to a similar end. Modern medical progress which has changed the treatment for tuberculosis has brought about the closing of the 1,800-acre, 145-bed sanatorium on Lake Kushaqua, and Stony Wold will also be offered for sale through Previews Inc., The National Real Estate Clearing House.

Stony Wold was founded by Mrs. Edward Newcomb in 1901 expressly as a sanatorium for working girls who needed tuberculosis treatment. It was she who raised the funds to establish the sanatorium. The Gould, Morgan and Rockefeller families were among those who contributed to its support. In later years the American Telephone and Telegraph Company was among its larger donors, and still more recently the City of New York has supported Stony Wold as a sanatorium for city workers.

During World War II Stony Wold served as a sanatorium for the treatment of Dutch and Norwegian seamen unable to return to their homeland.

CIRRHOSIS of the liver, long a fairly common chronic disease of adult life, now ranks among the ten leading causes of death in the United States, it is reported by statisticians of the Metropolitan Life Insurance Company.

At ages forty-five to sixty-four the only diseases which outrank cirrhosis of the liver as a cause of death are heart disease, cancer and cerebral hemorrhage. In 1956 cirrhosis accounted for a total of about 18,000 deaths in the United States, about two-thirds of them among males.

Emergence of cirrhosis as a leading cause of death resulted chiefly from the marked reduction in mortality from the infectious diseases, the statisticians add, although the increasing recorded death rate also may be due to improved methods of diagnosis and hence more frequent reporting of the disease on death certificates.

Cirrhosis of the liver shows marked geographic variations in its death rate, tending to be highest in the eastern industrial states and California, and lowest in the South and Southwest. Compared with a national average of 9.9 per 100,000 in 1950–1954, the death rate from the disease ranged from 3.7 in South Carolina to 18.5 in the District of Columbia.

Although the exact relationship of alcoholism to cirrhosis has not been definitely established, the statisticians point out that it appears that the alcoholic's diet, if deficient in protein and

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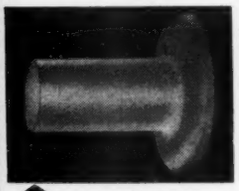

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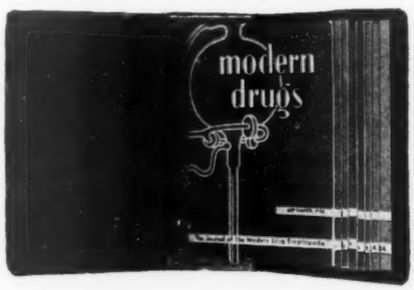

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certain vitamins, may predispose to cirrhosis. More than one-fourth of the deaths from the disease are reported to be associated with alcoholism, but the reporting appears incomplete.

Overweight adversely influences the mortality from cirrhosis, according to insurance experience. A recent study among insured overweight men showed that the mortality from the disease was two and a half times that of standard risks.

"The control of cirrhosis of the liver depends primarily on preventive measures, such as a balanced diet, moderation in the use of alcohol, prevention or treatment of infections harmful to the liver, and keeping the weight down," the statisticians note.

"Current methods of treatment are effective in mild and moderate cirrhosis, but further research is needed to develop adequate therapy for the advanced stages of the disease. Encouraging is the recent development of surgical procedures to combat the complications of advanced cirrhosis."

Four new families of powerful tranquilizing agents—some of them exhibiting twenty times the strength of chlorpromazine in animal tests—have been synthesized in a chemical "breakthrough" revealed to the American Chemical Society.

In a $1,000,000 research program sponsored by Eli Lilly and Company, Indianapolis, and involving the combined efforts of thirty chemists and pharmacologists in a long series of experiments, a new theory of tranquilizing action has been tentatively confirmed, according to the announcement. The research has led to the production of hundreds of potential tranquilizing compounds chemically different from any drug now available for the treatment of psychiatric patients. Clinical tests are under way, but the Lilly researchers cautioned that much work needs to be done before it will be known whether the new agents have a place in human medicine.

PERFECTION of a hard glass, known as KG-33 borosilicate glass, which will serve as a new source of supply for the nation's expanding laboratory and research requirements was announced today by Kimble Glass Company, a subsidiary of Owens-Illinois Glass Company.

The new glass, which company officials say matches or excels the performance of any similar hard glass now being manufactured, will be used by Kimble in its Kimax line of laboratory and scientific glassware items.

"Some 370 different Kimax items, each in a wide range of sizes and capacities, already are in production, and are now available from laboratory and surgical supply dealers," R. H. Mulford, president of Kimble, said in announcing the new hard glass. He also stated that KG-33 glass will eventually be used in all appropriate laboratory glassware items.

An ancient Egyptian, strolling along the banks of the Nile, observed the sacred bird, the ibis, apparently using his long bill to apply the river's soothing waters to his ruffled tail feathers.

This observation, so the legend goes, led to the invention of the enema, even though the Egyptian perception was not too acute. Subsequent scientific investigation has determined that the ibis was actually extracting oil from its uropygial gland, the better to preen its feathers.

Despite this analytical error, the Egyptians were among the first peoples of the world to recognize the therapeutic efficacy of the enema. Directions for its use are recorded in a papyrus dating back to about 2500 B.C.

This and other historical anecdotes describing the development of the enema from its early crude forms to the modern disposable plastic squeeze bottle are recounted in an illustrated booklet prepared by the Medical Service Department of the C. B. Fleet Co., Inc., Lynchburg, Virginia, manufacturers of the Fleet Enema Disposable Unit. The booklet, entitled "The Enema: Indications and Technics," is available free on request and is intended as a teaching aid for hospitals, schools of nursing and other professional groups.

THE AMERICAN MEDICAL WRITERS ASSOCIATION announced the 1957 Honor Awards for Distinguished Service in Medical Journalism at its annual meeting, held September 27, 1957.

Award for specialized magazines went to *The American Journal of Clinical Nutrition*, published bi-monthly by The American Journal of Clinical Nutrition, Inc.—a Yorke Group publication. Dr. S. O. Waife, Indianapolis, accepted the award for the Journal.

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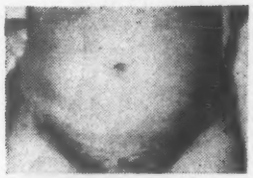

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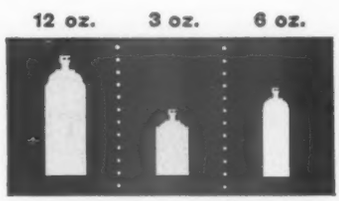

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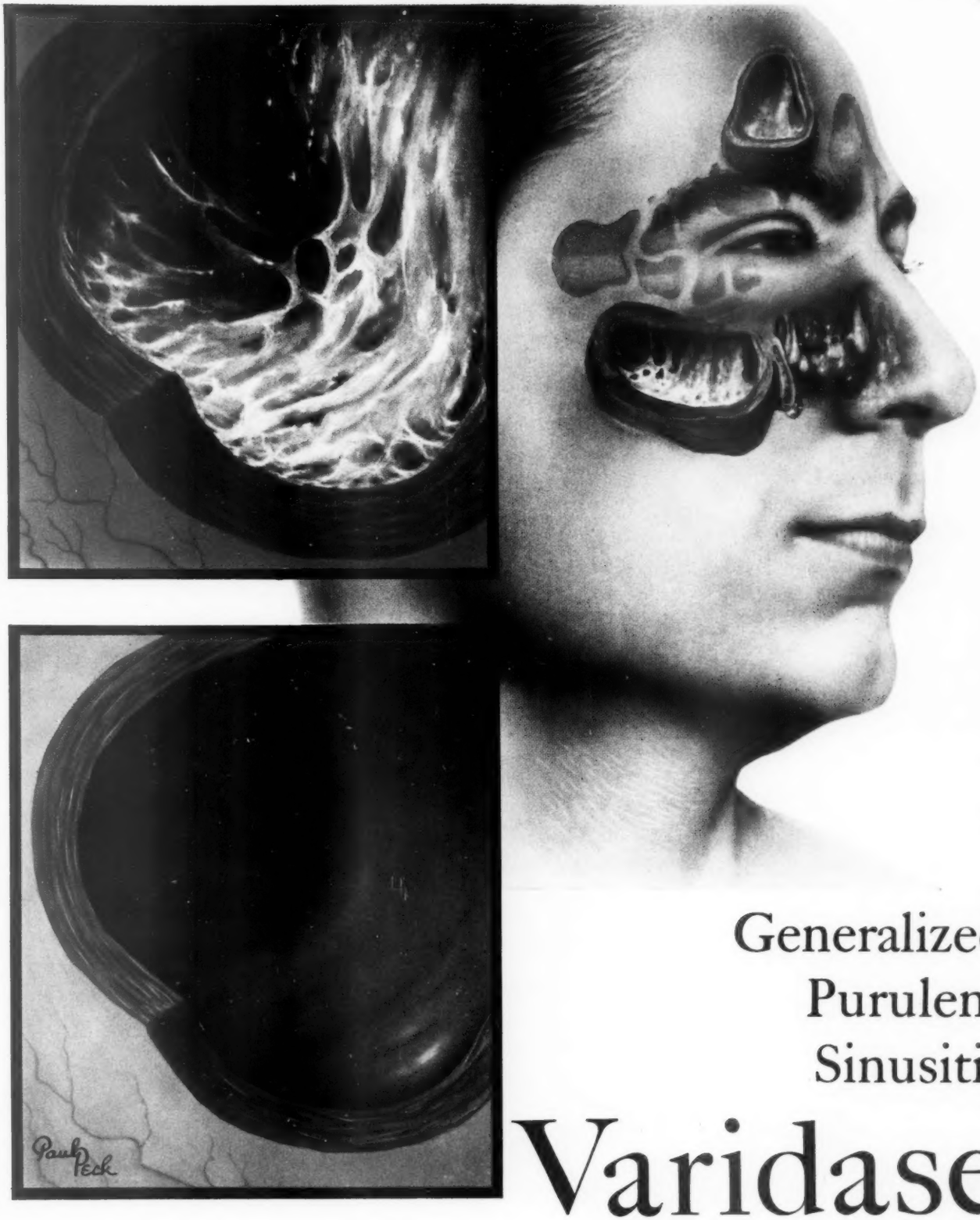

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1. Boger, W. P.; Strickland, C. S.; and Gylfe, J. M.: Antibiot. Med. & Clin. Ther. 3:378 (Nov.) 1956.

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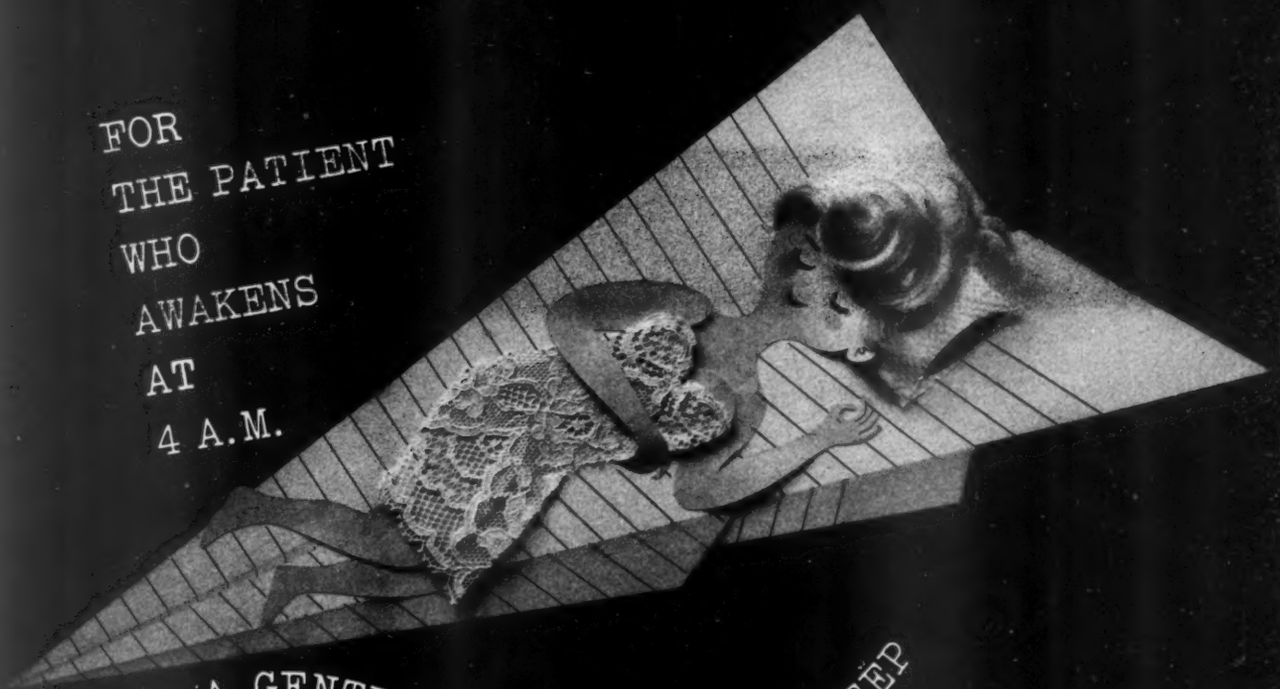

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